INTELLIVISION

HOW A VIDEOGAME SYSTEM BATTLED ATARI AND ALMOST BANKRUPTED BARBIE®

Platform Studies

TOM BOELLSTORFF
& BRAXTON SODERMAN

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Intellivision

How a Videogame System Battled Atari and Almost Bankrupted Barbie®

Tom Boellstorff and Braxton Soderman

The MIT Press Cambridge, Massachusetts London, England

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To everyone we interviewed
To Keith Robinson
To all those kids who got numb thumbs playing Intellivision

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Series Foreword

How can someone create a breakthrough game for a mobile phone or a compelling work of art for an immersive 3D environment without understanding that the mobile phone and the 3D environment are different sorts of computing platforms? The best artists, writers, programmers, and designers are well aware of how certain platforms facilitate certain types of computational expression and innovation. Likewise, computer science and engineering have long considered how underlying computing systems can be analyzed and improved. As important as scientific and engineering approaches are, and as significant as work by creative artists has been, there is also much to be learned from the sustained, intensive, humanistic study of digital media. We believe it is time for humanists to seriously consider the lowest level of computing systems and their relationship to culture and creativity.

The Platform Studies series has been established to promote the investigation of underlying computing systems and of how they enable, constrain, shape, and support the creative work that is done on them. The series investigates the foundations of digital media—the computing systems, both hardware and software, that developers and users depend upon for artistic, literary, and gaming development. Books in the series will certainly vary in their approaches, but they will all share certain features:

- a focus on a single platform or a closely related family of platforms
- technical rigor and in-depth investigation of how computing technologies work

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- an awareness of and a discussion of how computing platforms exist in a context of culture and society, being developed on the basis of cultural concepts and then contributing to culture in a variety of ways—for instance, by affecting how people perceive computing.

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Notes on Style

We provide an interviewee's full name and position on first mention, thereafter using only last name unless context necessitates additional detail (many held multiple positions; titles were sometimes inconsistent). Interview quotations are lightly edited for hesitations and digressions. We use italics when referring to books, videogames, and websites. When discussing a videogame unfinished before the closure of Mattel Electronics in January 1984, or turned into a different videogame, we use quote marks. When "Atari" appears with no other identifier, it refers to the Atari VCS (the Atari Video Computer System, also known as the Atari 2600).

Tense presents a fascinating challenge in the study of platforms. On the one hand, our focus is on the 1970s and 1980s. On the other hand, Intellivision still exists, and one can play it and code videogames for it. We primarily use past tense but occasionally present tense in statements like "Intellivision has two hand controllers."

When discussing data, we often use the well-known "kilobyte" (KB), which equals 1,024 bytes. This is based on the contemporary standard of 8-bit "bytes." However, Intellivision used 10-bit "decles," so a "kilodecle" (KD) is the equivalent of 1,280 bytes.

The term "frames per second" existed in the late 1970s and early 1980s, but it was rarely used and not within Mattel Electronics. We follow their practice of using hertz, so "60 Hz" is equivalent to "60 fps." Similarly, within Mattel Electronics (and Atari), "moving objects" was the term used for what are now often called "sprites." Since interviewees sometimes used the now-familiar term "sprites," we also use it on occasion.

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Around eighty interlocutors reviewed the initial draft of this book, and around fifty the final draft. These incredible acts of generosity helped us refine our analysis and correct factual errors. The brilliant insights of three anonymous reviewers selected by the MIT Press helped us frame our argument. We regret that Keith Robinson passed away before this project was fully underway. A programmer and Group Leader at Mattel Electronics, Keith helped sustain the Intellivision community and preserved most of the "Blue Sky Rangers" archives. Stephen Roney gave us permission to access and scan these documents, which not only made this book possible

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but preserved the documents for future generations. We owe Stephen our deepest thanks.

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Then there are those who make our working lives a possibility and pleasure.

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From Tom: I thank my husband, Bill Maurer, and my family at El Mondale: Gina Wallar, Brian Ulaszewski, and Carter Ulaszewski. I thank the rest of my family, particularly my mother, Neva Cozine, my father John Boellstorff, who bought me my Intellivision and played *Sea Battle* and *Triple Action* many a day, and my brother, Charles Boellstorff, who read through the proofs checking for errors. I thank my Long Beach community, including Elana Arnold, Angela Caranci, Gemma Davison, Susan Hwang, Melissa Infusino, Dominic Lakey, Matilda Davison-Lakey, Mark Taylor, Xander Taylor, and Tim Wright. A special shoutout to my MetCon and Reality families, including my coaches Chris Antonelli, Amanda Brown, Hugo Diaz, Edmond Ercout, Julian Erhard, Jason Funke, Jess Marantz, A. J. Rea, Trent Romleski, and Kenz Sheehan, and workout buddies including Hayden Almeida, Jennings Bennett, Jonathan Brady, Christina Hong, Ben Lomeli, Seija Rohkea, Tomas Salgado, Natalie Smerkanich, Tina Southern, and Jerry Wilson. I thank Braxton for years of colleagueship, starting with a coffee on campus and leading to a trek across the United States and driving around half of Southern California. Our adventures (including a broken windshield and lots of fast food) brought great memories and a wonderful research experience.

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Introduction: Intelligent Visions

Blue Skies

In a verdant park in Los Angeles, Intellivision programmers have come to dream up fantastic ideas for new videogames. They play frisbee, eat lunch, and brainstorm ideas in the open air. Despite their camaraderie and the agreeable surroundings, the programmers "struggle for inspiration," and only "toward dusk, the brilliant idea surfaced . . . The game, eventually called *B-17 Bomber*, would simulate an Allied aircraft flying over occupied Europe."[1] This story was recounted by the journalist Howard Polskin in *TV Guide*.[2] When we interviewed him years later, Polskin recalled his excitement at being assigned "to go behind the scenes of the creation of a video game." In February 1982, Polskin flew to Southern California, checked into the Beverly Hills hotel, and rented a Ford Thunderbird. Then he spent a day with Intellivision programmers who were brainstorming videogames in a corporate conference room and later at a restaurant. Open-ended brainstorming meetings were sometimes known as "blue sky" sessions, and Polskin called these programmers Blue Sky Rangers, cosmonauts who "probe the outer boundaries of the imagination for ideas."[3] In retrospect, Polskin realized that the conversations, interactions, and ideas he observed that day "foreshadowed what was going to happen in the computer revolution."

By the 1970s *TV Guide* was the most popular magazine in the United States, with a peak circulation around nineteen million.[4] A weekly directory of broadcast television was educating millions about a new phenomenon—

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0.1 The Intellivision Master Component, showing a *Major League Baseball* overlay on the right hand controller. Image by authors.

home videogame systems. That Intellivision would be featured in *TV Guide* reflects how well known the console was in the early 1980s. Intellivision was second only to the Atari VCS, the era's best-selling system.

TV Guide was a fitting venue. Intellivision, as its name suggests, made television "intelligent." The console, called the Master Component, was about the size of a videocassette recorder (VCR), then a cutting-edge consumer technology. The Master Component was designed for the home, with rounded corners and wood-grain plastic trim reflecting living room decor of the late 1970s. Two hand controllers each had a directional disc for movement and four side buttons. They were attached with a curly cord like those used for touch-tone telephones, and like telephones, the controllers featured a keypad with twelve numeric buttons (figure 0.1). Overlays placed into the controllers customized them for each videogame. Brainstorming new game ideas was possible because Intellivision was part of a generation of videogame systems, including the Atari VCS, that used cartridges.

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Polskin framed videogame design as play, with programmers tossing frisbees in a park, eating with colleagues, and decamping to local arcades. Labor mingled with leisure, moving from the office to the playground. Polskin also observed oppressive aspects of this process, emphasizing the toiling efforts of programmers "hopelessly addicted to their work," insistently prodded by their bosses to churn out creative ideas.[5] However, Polskin's article captured only part of the story. From documents saved by programmers, we know that *B-17 Bomber* evolved over a long period of time, developed by multiple staff members.[6] Videogame design was not always characterized by single authorship or playful inspiration but was embedded in everyday labor practices. As Mattel programmer Keith Robinson noted after Polskin's story was published, "*B-17 Bomber* evolved at the office, not at a 'brainstorming session.'"[7]

The office in question was part of Mattel Electronics—a division of Mattel, a major toy company best known for Barbie and Hot Wheels. Based in Southern California, Mattel's cultural and organizational history shaped Intellivision's videogame design just as much as the console's technical structures. The Applications Software group that met with Polskin was led by Gabriel Baum, hired because of his experience managing creative programmers and after working with Atari on educational language software. Early on, this group was part of "Design and Development," a department within Mattel Electronics directed by Richard Shih-Teng Chang, a talented engineer, toy designer, and manager who had worked at Mattel since 1962. Indeed, Chang often called brainstorming meetings "blue-sky sessions," and Mattel's research and design group was called the "blue-sky group" in the 1960s.[8] The brainstorming depicted by Polskin was part of a much longer tradition at Mattel to imagine and develop innovative entertainment products. Intellivision emerged from this tradition.

Polskin's perspective foregrounded Intellivision programmers' creative energy and playful links to Mattel—important themes we discuss. Yet in this book we turn from "blue skies" to "on-the-ground" creativity. We dig into the dirt, so to speak, revealing multifaceted technical and social practices that shaped the platform. We investigate Intellivision's origins, computational properties, and videogames. We examine its design, advertising, and marketing. We introduce the companies who collaborated to produce it and the people who worked to develop it. We also look outward, reflecting on what Intellivision teaches us about videogames, platform studies, and the social history of technology.

Intellivision's fascinating story is about a major toy company entering the nascent videogame industry and the wider market for consumer electronics and home computing. It is a story about competing visions for

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the future of videogames, about the exhilarating and risky experience of exploring uncharted markets, about the intoxicating boom of success and agonizing plummet of failure. It is a story about a videogame system that battled Atari and almost bankrupted Barbie—and along the way, it changed the history of videogames.

Intelligent Visions

The Intellivision system was sold by Mattel Electronics between 1979 and 1984. The "heart of Intellivision," as it was called in brochures, was the Master Component—the console with its central processing unit (CPU), graphics processor, and even an operating system. More than three million Master Components were sold. Around 125 Intellivision titles were released by Mattel Electronics, third-party videogame developers like Activision and Imagic, and even Mattel Electronics' archrival Atari.

While videogames are now largely understood in terms of technology, Intellivision's relationship to Mattel illuminates the value in linking game studies more closely to play and toys. Indeed, Polskin recounted how programmers were given toys to generate videogame ideas—at least at the meeting he observed. From Mattel's perspective—with play as its domain—games and toys were adjacent product categories. As Maaike Lauwaert has argued, game studies scholars typically "do not focus on the long-term historical perspective of play as a cultural practice, the role of technological innovations within this history and the changing dynamics between players, toys and companies."[9] Our book contributes to such analyses, examining videogames in terms of toys and play to explore how Mattel's status as a dominant toy company shaped Intellivision.

Mattel had a long history of producing innovative toys. Before developing Intellivision, Mattel repurposed portable calculators and invented "handheld" electronic games. These games used LED lights for their rudimentary displays and gameplay. As part of the broader home electronics revolution made possible by the introduction of microprocessors, portable calculators were a hot product in the early to mid-1970s, and their small format paralleled toys. The handheld games were massively successful, giving rise to an entirely new kind of toy, and to Mattel Electronics as a division of the larger company. They were also a useful transition from toys to developing a videogame system.

Handhelds were more expensive and complex than typical toys, requiring Mattel to forge relationships with technology companies in Southern California. One such company, APh Technological Consulting, was a small

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consulting firm from Pasadena, California, run by tech whizzes just out of college. Later, when developing Intellivision, Mattel partnered with both APh and General Instrument, an East Coast company looking to crack consumer markets to fuel sales of its microchips. Thus, Intellivision would emerge from a complex collaboration between a toy giant, a technology giant, and a tech startup.

Handheld games and Intellivision reflected transformations already underway in the toy industry. Observers noted that toys and games were becoming more sophisticated and integrated with technology, and Mattel was at the forefront of this transformation.[10] Mattel had been cultivating "adult games" as a subcategory of toys, and handhelds—with their sports emphasis and higher price—potentially strengthened Mattel's offerings to this older demographic.[11] This made sense because the market for games, both analog and digital, was expanding. "Gaming—Adults and Technology Enlivening Old Staple" read the title of a 1978 article in *Playthings*, a leading publication in the toy industry.[12] With their interest in new technologies and taste for strategy and casino games, adults were propelling game sales as an increasing percentage of annual toy sales. The article also identified "a feeling afoot in the land that continuing bad nighttime TV programming has a large number of adults turning off sets to turn on to games."[13] Gaming was growing, and from the toy industry's perspective sophistication was the future.

Enter "Intelligent Television," a way to tune out the trash on TV and switch on the smarts of videogames. Before Intellivision was even named, the console was publicly announced as the "most sophisticated, high-end console" coming to market.[14] This objective was echoed in the system's earliest design specifications, which sought to support "sophisticated game play."[15] While initially marketed to families, Intellivision's target audience was adult men and older boys, gendering this sophistication and reinforcing stereotypes associating television with femininity, domesticity, and passivity (the "boob tube") while linking videogames to masculinity, activity, and intelligence. This target audience also distinguished Intellivision from Atari, which appealed to children with its action videogames and simpler controls. In contrast, Intellivision's complex hand controllers, rich graphics, and strategic gameplay became synonymous with intelligence within videogame culture. During Intellivision's boom years, for example, a fan magazine ran a true-or-false quiz to help consumers pick a videogame system: "Reading *War and Peace* in the original Russian is my idea of a good time," the quiz posed.[16] If answering "True," the quiz suggested buying an Intellivision, ranking it the most complex system on the market.

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Understanding Intellivision requires grasping how intelligence was expressed through the system's hardware and videogames, its advertising, and its vision of the future. One way the console's sophistication was made "intelligible" was through realism. This aesthetic, which permeated Intellivision videogame design and marketing, included graphical realism—Intellivision titles looked more real than their rivals—but also realism in terms of gameplay, sports licensing, and voice synthesis. Intellivision's expression of realism had a lasting legacy on videogame culture, becoming a way that the public could grasp technological progress through the lens of videogames. Furthermore, Intellivision reinforced links between the computerization of society and intelligence, auguring a future of "smart" consumer technologies. In a sense, Intellivision represents an alternative history of artificial intelligence. This parallel history is less about training machines to think through code and more about encoding consumer technologies with an aesthetic of realism and intelligence that would teach humans to embrace new technologies as intelligent, all through the pleasures of play.

Intellivision's Double Horizon

While Intellivision was shaped by toys, its story was also about Mattel diverging from toys. During Intellivision's conception, programmable videogame consoles were emerging simultaneously with home computers, and the identities of both were in flux. This triggered an epochal debate regarding the future of home computing. As Chief Information Officer of Mattel during this time, Fred Held had an expansive understanding of the stakes of this "home computer versus videogame console" debate. When we interviewed him in his sunny living room, Held defined this debate in terms of "externalizing" computing, "cutting the cord between the end user and the mainframe." In the 1970s, computers were understood primarily in terms of mainframe systems internal to a laboratory or office. They were not part of the domestic world. Held explained that the language of externalizing computing was being used to ask, "Is the home computer going to come from gaming, or is the home computer going to come from people taking computers home?" Held paused, then spoke: "I was saying it was going to come from gaming. I was wrong." Videogame systems did not evolve into personal computers—a future where Nintendo, Sega, and PlayStation became word processors—yet Intellivision pursued this doomed dream.

Intellivision was swept up in the rise of home computers. In the late 1970s, some felt that videogame consoles were a fad and that home computers that played games would quickly make consoles obsolete.[17] One response

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to this was to develop separate products. Atari had its VCS videogame system and its 400/800 computers (which also played games).[18] Another response was to merge console and computer. Mattel Electronics followed this path. Its videogame system became the "Master Component," with the language of componentry indicating it was part of a larger structure. An early brochure called Intellivision "a revolutionary network of video hardware and software," a description that does not foreground videogames. By the time Intellivision was test-marketed in late 1979, Mattel Electronics was promoting an expensive Keyboard Component promising to turn the Master Component into a sophisticated computer. Mattel, a toy company, was going to sell computers.

Part of our story concerns how Mattel, a giant of the toy industry, birthed Mattel Electronics, a corporate division that would grow to overshadow Mattel Toys before crashing spectacularly. From one perspective, Intellivision is a tragic story about a toy company that lost its way as it was growing up, taking risks that almost caused Barbie to drive off a cliff in her Hot Wheels convertible. From another perspective, it is a rollicking adventure where an innovative toy company transformed itself, creating a sophisticated videogame system that tried to slay the goliath of Atari while producing experimental computer add-ons with their own playful charms. Ultimately, the tension between videogames and computers, and toys and hi-tech devices, caused turbulence at Mattel. This turbulence appeared in the ways that Intellivision was marketed, in corporate disagreements about the path Mattel Electronics should take, and in its visions for the future of videogaming and home computing.

Two figures who appear throughout this book, Richard Chang and David Chandler, stand out as key representatives for these differing visions. Both were engineers indispensable to Intellivision's conception and development. Chang, mentioned earlier, designed toys and led the team that first envisioned the idea for Mattel's programmable videogame system. David Chandler—an engineer whose background included developing a missile guidance system, a word processor, and an arcade videogame—was hired in 1977 and given control over Intellivision's development. Chang cut his teeth on toys and their integration with technology; Chandler rose from the aerospace industry and business computers. Chang created sophisticated toys and games to enrapture children and was a key figure who brought electronics to Mattel; Chandler came to Mattel and supported a vision that entertaining videogames would catalyze the arrival of home computing. In later chapters we explore what Chandler called his "philosophy" of Intellivision—where videogame consoles are not viable in the long term but through extensions can operate as the foundation for a computerized home of

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entertainment, connectivity, productivity, and self-improvement.[19] Following Chang's influence, we explore the slightly different idea that videogames extend the toy category of games, with home computing magnifying play and creativity instead of productivity and self-improvement.

These are competing visions regarding what we term the "platform futures" of videogames. At Mattel Electronics, these visions played out in organizational debates and development priorities, sometimes taking the form of bitter conflict. However, they also took the form of collaboration and shared goals. This was possible because Chandler and Chang's platform futures were not diametrically opposed. Both understood that the home would transform the use of computers, imported from the world of business and science, and that the console and computer would converge in the domestic crucible to create something new. They diverged in their understanding of how computing would be used within the home and what it would be for. Would the videogame machine's power be hijacked for productivity, self-improvement, and connection to the external world, or would computing be used to augment entertainment and the console itself, transforming its creative uses?

Platform Extensions

When we set out to write a book about Intellivision, we thought we knew what it was—a console developed by Mattel that had better graphics than Atari, funky controllers, and fascinating videogames that captivated us long ago. Intellivision was this, but we discovered it was much more. There were add-ons to create home computers, download videogames through cable television, synthesize voice, and even play Atari cartridges.[20] Since the Master Component was known as "Intellivision" in the marketplace and sold far more than its add-ons, these extensions might appear tangential. In fact, they are central to understanding Intellivision's significance, and each shaped the platform in its own way. Analyzing the multiplicity of Intellivision and its "holistic network" reveals how Intellivision was conceived at the time, instead of merely how it is perceived today.[21]

While this book could have focused on the Master Component and its videogames, relegating its peripherals to the periphery, this approach would miss key ideas that animated Intellivision's development and historical impact. Such an account might adopt a "name to the game" approach, limiting focus to memorable titles and the programmers who made them. This would elide the vital role of those who worked on unreleased titles, on multiple titles as graphics or sound experts, on hardware, or as managers, marketers, testers, and so on. In contrast, it is crucial to explore

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never-released videogames and "peripheral" hardware—extensions that were released but sold only a few thousand copies or quickly disappeared. Benjamin Nicoll has developed the idea of "minor platforms" to "describe a set of objects, subjects, and spaces that are, for various reasons, ancillary to conventional narratives of videogame history."[22] Intellivision itself was both major (selling millions) and minor (playing second fiddle to Atari), and forgotten peripherals, videogames, and experiments proliferated within its ecosystem. Analyzing these dimensions of Intellivision recovers the minor within the major platform.

Intellivision's modular extensibility, as we call it, was an essential part of its identity. Modular extensibility was pervasive in the early videogame industry—related to disruptive innovation and product differentiation as companies explored bringing digital technologies into the home.[23] Mattel Electronics made it fundamental to its business plan. Extensions emphasized system expandability, suggesting added value, utility, power, and longevity to justify expensive purchases. Modularity suggested standardization, the ease of adding components, and flexibility through consumer choice. One catalog explained, "We have created a system of modular componentry that keeps Intellivision perpetually current." Such language aimed to bridge the divide between videogame systems and home computers through an analogy to stereos, a familiar consumer technology where one purchased a core device and then "added on" other devices like speakers or a turntable (figure 0.2). Instead of buying either a videogame system or a home computer, the consumer could have both through add-ons.

Modular extensibility made economic sense for Mattel Electronics, since add-ons promised to keep Intellivision viable in a fast-changing market. It responded to the unfamiliar complexity of videogame systems and home computers: consumers could learn a system piece by piece, incrementally educating themselves about features and potentials. Moreover, modularity helped a toy company tackle complex products incrementally, a dynamic felt industrywide.[24] Marketing could also advertise Intellivision's modular extensibility to differentiate it from rival consoles like the Atari VCS. Why would a consumer pay $100 more for Intellivision? One powerful reason was the promise of future expandability.

Thinking in terms of extension was familiar at Mattel. Mattel's marketers embraced the common practice of "line extension," for instance, adding Malibu Barbie to the Barbie product line or adding longevity to Barbie's success through a never-ending line of accessories. This practice became a hallmark of Mattel. Videogame cartridges functioned similarly, and add-ons such as the Keyboard Component carried this logic into hardware. While companies used the terms "expandability" and "expansion" to discuss

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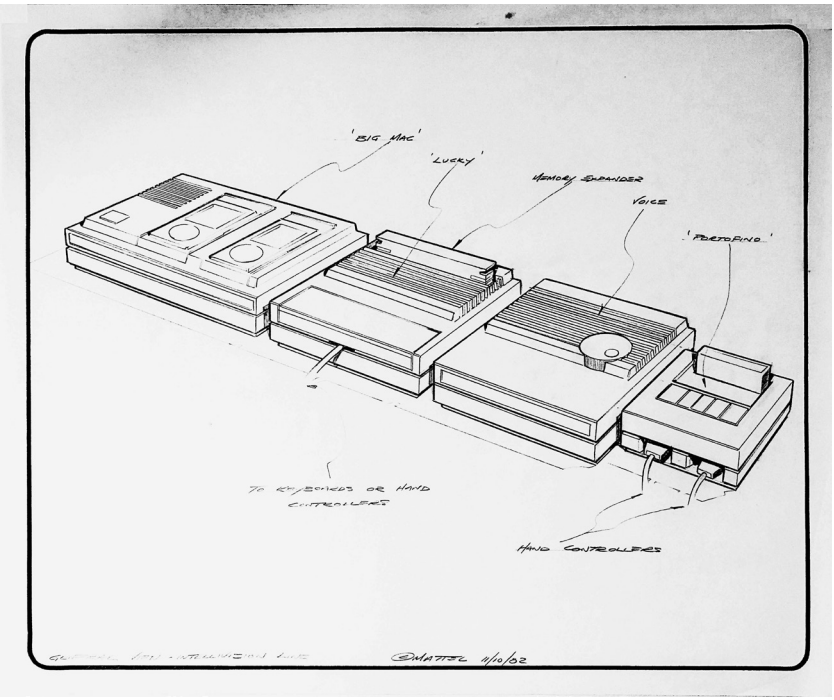

0.2 A conceptual drawing of Intellivision with its extensions (by Ted Mayer). This image shows Intellivision II (known within Mattel Electronics as "Big Mac") with several extensions: the Entertainment Computer System ("Lucky"), Intellivoice ("Voice"), and the System Changer ("Portofino").

systems and their add-ons, we often use "extensibility" and "extension" to tailor the concept to Intellivision. Expansion favors technology, adding new power and capabilities to a system, while extension suggests stretching a concept—like extending the idea of Intellivision's sophistication through additional hardware. In a contemporary context "insiders use the term 'extension' to refer to their efforts to expand the potential markets by moving content across different delivery systems," which dovetails with Mattel Electronics' later work to spread Intellivision content to other platforms.[25] Overall, Mattel Electronics embraced the concept of modular extensibility throughout the console's lifespan, even when this led to a hyperextension of software and hardware development, sapping resources and fueling an overextension that contributed to Mattel Electronics' implosion.

Extension was ingrained in the ways that Mattel Electronics designers and executives thought about technology, revealing a broader worldview. They understood Mattel Electronics' two major product lines—handheld

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games and Intellivision—in terms of a distinction between "self-contained" and "system." Handheld games were categorized as self-contained because each included everything needed for play—display, sound, and controls. Intellivision, in contrast, was categorized as a system because it was based on extension. This began with the television (without which Intellivision could not work) and extended to videogame cartridges and additional hardware. The distinction between self-contained and system articulated a fundamental conceptual demarcation, emerging from a world in flux due to computerization. "The home video phenomenon has emerged as the event of the 1980s," read one Mattel Electronics catalog, "Its possibilities are far-reaching and its uses almost endless." Intellivision was Mattel's answer to this expanding world of technology, conceptualized to evolve with the times.

Given this imagined, unlimited world, it is unsurprising that Intellivision and its competitors were consistently called "systems." Atari VCS stands for Video Computer System, the Fairchild VES (Channel F) was the Video Entertainment System, and the NES was the Nintendo Entertainment System. The anthropologist Valerie Olson has argued that "system" has become "a technology for putting conceptual and material relations together."[26] For instance, an ecosystem includes predators, prey, shelter, and migration patterns, but also climate, soil, and the human impacts of residence, agriculture, and policy. Drawing on this framework, we treat the Intellivision "system" as including the Master Component, videogames, extensions, social relations (for instance, between programmers and marketers), and materials like documents and development tools. It includes organizational dynamics, computational elements, and competitive rivalries between Intellivision and Atari. In a sense, we treat these different pieces as modular components that combine and intersect, and that we interweave to articulate the system as a whole.[27] This approach aligns with what Intellivision was when it was developed and sold—a platform "assemblage" that, as Alex Custodio described, "comprises various articulations, which include concrete elements, agents, and collective subjects, as well as networks of external relations that keep them together."[28]

As Carl Therrien has argued, expandability is useful for understanding how videogame systems are constantly in flux—"shaky platforms" where hardware expansions, tools, code, and discoveries like programming tricks proliferate new ways to use a platform.[29] Intellivision exemplified this process. Each extension had its own peculiarities, shifting Intellivision's use. Sometimes, as in the case of the Keyboard Component, a drastically different approach to the underlying platform appeared, transforming Intellivision from a videogame console to an interactive audiovisual machine. Different "Intellivisions" emerged at different times, articulated by intersecting

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technical and social practices—what we call affordance zones. This was another phenomenon already familiar to Mattel. The company's founders, Ruth and Elliot Handler, even had a term for similar affordance zones emerging from the material and social production of toys: they called them "principles" and iterated numerous toys around the conceptual themes and technological mechanisms that formed these principles.

In this regard, Intellivision illustrates how "platform capitalism" is not a digital transformation but is related to economics and forms of material production.[30] Marc Steinberg has claimed that "in Toyota's post-1950s management innovations we find many of the elements central to definitions of platform capitalism."[31] This includes the notion of a "platform" (a term used for an automobile chassis since the 1970s) and a "stack" framework where multiple Toyota vehicles "share the same underbody as well as other essential components such as the engine."[32] Steinberg thus argued for the importance of what is widely known as "Toyotism," asserting that "platform capitalism may best be described as *automobile platform capitalism*" emerging after 1960.[33] We share Steinberg's desire to "denaturalize assumed equivalences between platforms and the digital."[34] Indeed, beginning in the late 1940s, Ruth and Elliot Handler pioneered forms of platform capitalism based, for instance, on a music-producing unit that could be extended into a range of toys. Before Toyotism there was "Mattelism," an economic framework of *toy platform capitalism* that has a direct lineage to videogame platforms, even shaping how contemporary videogames are designed, sold, and played.

The Age of Intelligent Television

Intellivision has largely been ignored in general histories of videogames.[35] For instance, the 608-page *Ultimate History of Video Games* contains only one dedicated page discussing Intellivision.[36] In *Before the Crash: Early Video Game History*, Intellivision appears only twice. Michael Newman's excellent *Atari Age: The Emergence of Video Games in America* mentions Intellivision ten times in passing, compared to thirty-seven often multipage discussions of Atari.[37] We amend this exclusion. While a book like *Atari Age* characterizes the broad philosophies of an era, necessarily sacrificing specificity, platform studies can articulate a more nuanced analysis, charting a specific console's response to a historical context while simultaneously analyzing wider cultural, social, and economic trends.

For example, in describing the rise of the videogame industry, Stephen Kline, Nick Dyer-Witheford, and Greig de Peuter argued that "toy companies decided that, with their foot already in the door of children's lives,

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they and not the upstart electronics firms were the heirs apparent to the video game market," adding that "toy companies believed they were the exemplars of innovative management who could properly handle the new media."[38] This idea contains some truth, but the reality at Mattel was more complex. Mattel's established R&D structure aligned with the rapid pace of technological change in the consumer electronics and computer markets, and leadership during the boom years embraced the toy industry's claim to ownership of videogames. However, this selfsame leadership was initially reluctant to move into programmable videogames and computers, and most managers and engineers advocating for Intellivision were recent hires from outside the toy industry. Mattel Electronics eventually split from the Toy division to gain freedom from its control. After Mattel Electronics' downfall, Mattel liquidated videogames and its electronics division in lightning fashion, as if excising a malignant tumor. The story of Mattel and videogames is not simply one where a toy company positioned itself as the rightful owner of videogames and new media but of a reluctant company moving awkwardly into a new industry and torn apart from the inside.

One facet of platform studies—which often focus on a single platform—is to add specificity to broader historical transformations, tracing how a platform is both particular and general. Many platforms emerged during the late 1970s and early 1980s, and each responded to this moment in various ways. Thus, Intellivision was both exemplary of an era and an idiosyncratic response. In addition to the rise of home computing discussed previously, other contextual factors fundamentally influenced Intellivision: the rise of second-generation videogame systems, the television, and the arcade.

Intellivision and several of its rivals were "second-generation" systems. In 1977, one industry observer proclaimed that "the Electronic Game market has recently begun its second generation with the introduction of the Fairchild Video Entertainment System," and by using "game information from a cartridge," the player "now has unlimited game possibilities. This differentiates this system from first-generation types which have fixed capabilities."[39] First-generation consoles like Atari Home Pong (1975) and the Coleco Telstar (1976) played one game or a selection of games. New videogames could not be added after these systems were sold. An industry overview commented on "the introduction of programmable video games in the fall of 1976," noting that "this second generation of video games" used "plug-in ROM-based cassettes," thus "enabling the consumer an unlimited number of games."[40]

Mattel's history reveals the second generation not only as a revolutionary period when software was separated from hardware but also as a time of continuity, teaching us that there are alternative chronologies of videogame history beyond the technological. For Mattel, the videogame "revolution"

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was another way to sell the toy category of games. As mentioned earlier, since the late 1940s Mattel had used technical mechanisms as platforms to produce new toys. While not programmable digital machines, these mechanisms shaped how toys were produced and purchased, even allowing consumers to purchase and insert different media to produce different output. The distinction between cartridges and consoles resonated with a longstanding "razor/razor blade" model for toys. This model was key to the success of Barbie, where consumers bought the doll but most revenue came from the sales of clothes and accessories purchased separately.

Nevertheless, the second generation—sometimes called the Golden Age of videogames—was a paradigm shift toward programmability and possibility for endless production, transforming videogame design and the industry's revenue model to the present day.[41] While one observer at the time called Intellivision "the archetypical second generation game machine," the best-known system was the Atari VCS (also known as the Atari 2600), released in the fall of 1977.[42] In three years, Atari's sales rose from $75 million to $2.2 billion, the fastest growth of any company in US history to that point.[43]

Of course, second-generation systems were not identical. The Atari VCS had a small amount of random-access memory (RAM) on the console and a graphics chip that required the fastidious attention of the programmer to display graphics on a television. All Atari game code came from its cartridges. In contrast, Intellivision contained more RAM than Atari, a graphics chip that automated displaying the image, onboard predefined graphics, memory for programmer-defined graphics, and even an operating system. Such features freed space on cartridges for more gameplay and graphics, and they had important ramifications for the sophistication of gameplay, the aesthetic look of Intellivision games, and sociotechnical practices of programming.

Any system from the time—Atari, Odyssey^2, ColecoVision—could illustrate common themes in platform studies. Technological constraints drive creativity and shape videogame aesthetics in surprising ways; technology determines a platform's character; social and cultural forces influence technology and can be detected in its structures. These themes are important to understanding any platform, and they often appear within this book. However, platform studies can add system specificity to such arguments. Constraints encourage creativity, yes, but what more can be said given a system's particular characteristics? For example, Intellivision created specific technical constraints and unique ways to overcome them, allowing us to understand emergent social practices of navigating technical "tradeoffs." As Mattel programmer Jane Terjung explained, while "the Atari was

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a set of beautiful oil paints and a brush, Intellivision was more like paint by numbers, a coloring book where the lines are already there." Here, the constraints of distinct systems are valued and imagined differently in terms of their visual aesthetics and the skill required to navigate them.

If the second generation was a moment when unique technological platforms emerged with their own idiosyncratic structures and aesthetics, it was also a moment when singular platforms were challenged technologically, economically, and conceptually. Cartridge ports opened outward and into the future, promising extended computing power and added functionality—promises that Intellivision's modular system embraced. However, the cartridge port also operated as a port of entry for competitors' products, creating new economic opportunities for other console makers and third-party videogame developers. The second generation is thus characterized by rivalry and experimentation. Indeed, Intellivision must be understood in relation to other systems, particularly Atari. A "transplatform studies" approach, as we call it, is necessary to appreciate how second-generation platforms were developed and experienced.

Second-generation systems also involved transplatform relations with the ur-platform of the second generation, the media technology of the cathode-ray tube (CRT) television. In the 1970s, television was being transformed into an interactive technology.[44] A significant development in this regard was the success of VCRs, which allowed viewers to record and replay broadcast television programs. One 1976 analyst called this "a 'video revolution' which ushers in the era when a person can control the television picture rather than just watch it."[45] Yet televisions also could be "programmed" like a platform using digital electronics. An early example was the "TV Typewriter," described in the September 1973 issue of *Radio-Electronics*, which taught hobbyists to build a keyboard that would allow them to type words on their television.[46]

The console's name, "Intellivision: Intelligent Television," oriented the system toward revolutions in television interactivity. Mattel's core products were toys for the home, where the television occupied a privileged place. It made sense for Mattel Electronics to transform the domestic television into an interactive plaything, seeking to rechannel the profits of broadcast networks toward play. In 1982 Bill Gillis, Vice President of Marketing for Mattel Electronics, told an audience of retailers that "Intellivision will condition people for the future, for when television will be a primarily interactive device."[47] As its portmanteau name indicates, "Intellivision" was to upgrade the television from something dumb (as indicated by slang of the time, like "idiot box") into something intelligent—a conduit for entertainment, education, self-improvement, and even domestic productivity. While some call

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the early period of videogames the "Atari Age," at the time most experienced it as an "Age of Intelligent Television." This phrase invokes the creative technological exploration of the time while better reflecting how engineers, programmers, and marketers envisioned the period.[48] No doubt, calling it the Age of Intelligent Television suits our interests, but we suggest it both in seriousness—because of its accuracy—and as a playful nod to the rivalry between Atari and Intellivision that also shapes this book.

During this period before smartphones or other personal screens, television was central to domestic life. It was also central to Intellivision. Television technology shaped Intellivision's hardware and game programming. It shaped Intellivision's visions of home computing. It impacted the aesthetics of Intellivision videogames, including their graphics and use of color. Televised sports profoundly influenced Intellivision's sports titles, a key genre that propelled the console's success. Mattel revolutionized the toy industry through its innovative marketing and use of television commercials. This history was replayed in the famed rivalry between Atari and Intellivision, fought on national television. Mattel Electronics leadership acquired licenses for television cartoon characters, entered into relationships with cable television for downloadable games, and even pursued collaborations to produce videogames for dial-in television programs. From the perspective of Intellivision's broader development and history, the Age of Intelligent Television was about more than making television interactive. It was about television's ubiquity as the technical and social platform on which the videogames industry arose.[49]

Intellivision's fundamental link to the home television positioned the system in relation to a third context: the arcade. Intellivision emerged during a time when arcades were "the first place a generation encountered computers and learned what it meant to play, to work, and to live in the age of computerization."[50] By 1980, there were approximately twenty-three thousand arcades in the United States.[51] Newman explained that home consoles "were advertised as recreating the arcade experience," which was true in some instances and particularly for Atari.[52] Its cartridges often mimicked arcade gameplay, including licensed titles like *Pac-Man*. Yet the domestication of videogames even shaped Atari: "Controllers and peripherals were fashioned for use on the floor or the couch. The games made for the platform are likewise oriented toward home use."[53]

Intellivision's relationship to the arcades was more nuanced. Unlike Atari, a company heavily invested in the arcades, Mattel's toy business was aligned toward play in the domestic space. While Mattel Electronics eventually developed arcade titles, the first twenty Intellivision cartridges released before January 1981 included only two with unequivocally arcade-style

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gameplay.[54] Leadership at Mattel Electronics had a much more expansive vision than simply recreating an arcade at home. Chandler explicitly contrasted Intellivision with arcade videogames—emphasizing that while "the coin-operated game is really geared at a short-lived experience," Mattel sought "to develop something that really fit the home environment instead of just translating the arcade environment into the home."[55] Chandler's "something" was not what Newman termed "recreating the arcade experience." For instance, to be profitable, arcade videogames were designed to last only a couple minutes. But the Mattel programmer Don Daglow recalled a common phrase among Intellivision programmers: "We're not trying to get another quarter. They've already bought the game."

Methods

This book is part of a field of research known as platform studies. In their groundbreaking study, *Racing the Beam: The Atari Video Computer System*, Nick Montfort and Ian Bogost defined platform studies as "the investigation of underlying computing systems and how they enable, constrain, shape, and support the creative work that is done on them."[56] *Racing the Beam* has been joined by a growing body of computing platform scholarship examining, for instance, the Nintendo Entertainment System, Commodore Amiga, and Nintendo Game Boy Advance.[57] Platform studies quickly evolved, and "the concept of platform itself has been expanded to encompass commercial strategies and cultural forms," with authors emphasizing how "a platform is a technology and a culture and a marketing construct, and these elements are indissociable."[58] We build on this scholarship, all of which seeks to "connect computing with culture."[59]

Platform studies has been praised and critiqued. It is valuable to avoid treating "the platform as the 'base' or most fundamental level" compared to economics or culture.[60] However, some critiques of platform studies are less convincing—in particular, the idea that focusing on one platform "becomes too confining."[61] While we contend that scholars should pursue transplatform analysis, it is precisely by focusing on Intellivision that we explore how "the materiality of platforms can be turned inwards to examine the individual components of a platform, and just as easily outwards to focus on the organizational structure that allows the platform to be produced."[62] This allows us to locate and transcend the platform—for instance, by showing how it includes everything from marketing to gameplay to multiple companies beyond Mattel Electronics.

As coauthors, we share a history of growing up with Intellivision. This project is thus motivated in part by nostalgia, albeit a critical nostalgia

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invested in understanding (not recreating) the past. It is also motivated by our intellectual histories. We have longstanding scholarly interests in technology and society, shaped by our academic homes in anthropology and media studies.[63] In 2014, this project began when we met at the University of California, Irvine, where we both teach, and discovered our shared interests regarding Intellivision.

Neither of us have backgrounds in computer science or videogame design, though we both play videogames avidly and are familiar with coding and the technical structures of digital media. Like any technical system, there are deep structures appreciated by highly trained electrical engineers and computer scientists, but Intellivision's computational structure made the console relatively accessible. This shaped hiring practices, allowing a candidate's creativity to be considered beyond mere technical expertise. It allowed someone with an acting degree and only six months' training in programming to find a job at Mattel Electronics—or, for that matter, it allowed an anthropologist and media studies professor to write a book about Intellivision.

We also discovered, by a huge stroke of luck, that the company that held rights to Intellivision, Intellivision Productions, was located only a few miles from our university! Meeting Mattel programmers William Fisher and Stephen Roney, and their generosity in allowing us to dig through their archive, catalyzed our collection of materials and also our ever-expanding network of connections within the Mattel universe. Eventually we assembled a massive archive of thousands of pages of documents, including everything from memoranda to videogame code.[64] About 80 percent of the files were saved by a single person, Keith Robinson, and included materials gathered from other programmers. These materials appear in the bibliography as the "Blue Sky Rangers" archive. We obtained additional documents from many other individuals. All these materials chronicle work at Mattel Electronics, and to a lesser degree the companies APh and General Instrument.

Complementing this archive, and the real heart of this book, are the 150 interviews we conducted.[65] Most were between 90 and 120 minutes, but some were as long as seven hours, with approximately four hundred hours of total recorded material. Many of those involved with Intellivision still lived in Southern California, so about half took place in person prior to the COVID-19 pandemic. The fact that we conducted this research approximately four decades after the events discussed may represent a "sweet spot" for interviews. The majority of those we wished to interview were still alive, but so many years had passed that questions of intellectual property were moot, and the emotional highs and lows of that exciting, turbulent time had faded. In many cases, we could send interviewees relevant documents ahead

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of our conversation. This stimulated discussion with specific names, dates, and events. It was often touching to witness someone see a memo they had written decades earlier and presumed had been forever lost.

Only about 20 percent of our interviews were with programmers; we also interviewed executives, marketers, and other organizational staff, as well as chip designers and hardware engineers. By working with these individuals, we utilized the technical expertise of the Intellivision era. This provided a way to get closer to the machine, so to speak, through an engagement with its designers, suggesting methodological possibilities for future platform scholarship. We also drew on contemporary experts, particularly "decle" and Joe Zbiciak. Their remarkable insights vastly enriched our understanding, showing that platform cultures extend far beyond the historical apogee of a platform's use.

Our methods are grounded in ethnographic and textual approaches from the social sciences and humanities. All of our data—documents, interviews, and code—constitute an empirical archive that we treat as a source of theory as well. Throughout this book, we do not use interviewee quotes as "name-dropping," nor do we reduce narratives to colorful vignettes. Rather, we treat interviewee quotes as the empirical and conceptual material through which we articulate our own claims.

Our discussion of Intellivision focuses on the US videogame industry. Unlike the following period that was dominated by Sega and Nintendo, during the second generation, US-based firms accounted for over 99.5 percent of home videogame system sales.[66] However, Intellivision was manufactured internationally; it was also sold in Europe, Australia, Japan, and elsewhere. Even some game design took place in France, Hong Kong, and Taiwan. While we briefly discuss some of these transnational connections, our analysis of "the industry" refers to the US videogame industry unless otherwise specified.

We both have an interest in the "archaeology" of videogames, shaped by our own backgrounds in media studies and anthropology.[67] The materiality of computational platforms like Intellivision lends itself to what we call "platform archaeology." This extends the idea of media archaeology, "a hermeneutic reading of the 'new' against the grain of the past, rather than a telling of the histories of technologies from past to present."[68] Through our analysis of toys and relatively minor extensions to Intellivision's platform, we share media archaeology's interest in the marginal and rethinking common historical narratives, but we draw inspiration as well from notions of archaeology linked to its original discipline of anthropology. Unlike geology, archaeology explores what we can understand as "near history." It seeks that which is not so far underground, revealing layers of time beyond official records.

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Archaeology is also emergent: you don't know what you will find when you dig. One might begin with an interest in buildings but encounter a rich trove of pottery shards and turn to focus on cooking practices.

Structure

While this book focuses on Intellivision's heyday, the social relations forged at Mattel Electronics influenced the system beyond its mainstream demise in 1984. In addition to saving so many key documents, Robinson was one of several former programmers, including Roney, who disseminated Intellivision's history through the "Blue Sky Rangers" website (adopting Polskin's phrase). In our research we discovered notes to a book Robinson had hoped to write, "Crash of the Blue Sky Rangers." That title might seem like a narrow nod to a group of programmers, but the outline of Robinson's book reveals something far more multidimensional. One chapter was to include not just the "history of video games" but the organizational history of "starting to build an in-house staff" at Mattel Electronics. Another chapter, "Expansion," was to include the establishment of overseas programming groups, as well as the development of next-generation systems. Like Robinson, we recognize the Intellivision platform as the product of social and material relationships with complex and contingent histories.

Our book, *Intellivision*, is organized into three parts: "Formations," "Practices," and "Extensions." These signal a basic chronology. Though we do not follow a strict historical account, generally we explore foundational events and technologies first, with subsequent developments addressed in later chapters. For example, we begin by discussing the history of Mattel, then the boom years of Mattel Electronics in the middle, with the 1983 crash of the US videogame industry saved for the end. Yet some chapters address conceptual ideas where chronology is less important, or examine technologies spanning large periods of time.

Part I, "Formations," consists of four chapters that explore the cultural, economic, and technological contexts of Intellivision's emergence. Chapter 1, "From Toys to Technology at Mattel," investigates the Southern California milieu from which Intellivision arose. We examine how Mattel's innovations in advertising, marketing, and toy development helped set the stage for their move into videogames. We also introduce pivotal collaborations with APh, which would be indispensable to Intellivision's development. Chapter 2, "The Master Component," recounts the origins of the console, the technological innovations that made it possible, and the crucial role that sports played in the early years of the system. Here, we weave a discussion of General Instrument's key role developing Intellivision with

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an analysis of the console's chipset and hand controllers. Chapter 3 turns to the Keyboard Component, the remarkable attempt to turn Intellivision into a home computer. We explore the component's development, the innovative software designed for it, and the challenges Mattel Electronics faced bringing it to market. Chapter 4 examines Mattel's "Marketing Magic," which was legendary and is crucial to the history of videogame culture. We discuss Mattel's marketing practices, the notion of "play value," and the influential George Plimpton commercials that propelled Intellivision's initial success. We also explore how realism was coded into the platform, and how Intellivision marketing and game design were shaped by gender and race.

The four chapters comprising part II, "Practices," turn to the platform culture within which programmers developed Intellivision videogames, including the everyday contexts in which these videogames were created and promoted. Chapter 5, "Ladders of Design," investigates the "rungs" of the Master Component's platform, from the bottom rung of the hardware, to higher rungs like the EXEC operating system, learning techniques like the trainer program Killer Tomatoes, and development tools like Mr. Color. Programmers developed practices around these rungs that shaped game design. Chapter 6, "Making Videogames," explores how design practices took form through interaction within and between organizations, everyday office interaction, training, and emergent forms of collaboration. Chapter 7, "Affordance Zone," delves further into videogame design, investigating how computational features of Intellivision were not always experienced as constraints—and furthermore, how factors like deadlines and licensing played an important role in game design. In chapter 8, we explore the boom period from the 1980 to 1982 Christmas seasons, when Intellivision and the home videogame industry seemed unstoppable. During this time, Mattel Electronics both iterated on past success, like developing its reduced-cost Intellivision II, and hyperextended into domains beyond Intellivision's original focus, including pivoting from sports to space games, developing videogames for Atari, and promoting Intellivision through competitions that represent early incarnations of esports.

Part III, "Extensions," contains five chapters exploring how Intellivision extended beyond the Master Component. This includes how Intellivision's overextension shaped the system while contributing to the crash that shuttered Mattel Electronics in January 1984. Chapter 9, "Intellivoice," investigates how efforts to make the console speak led to a complex and novel form of videogame design extending Intellivision's associations with intelligence and realism. Chapter 10 charts how the Entertainment Computer System (ECS) add-on did more than replace the failed Keyboard Component: it articulated a distinct vision of how gaming and computing could converge

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around notions of user modification and play. Chapter 11 examines PlayCable, a remarkable technology that from 1980 to 1984 allowed consumers to download Intellivision videogames via cable television. In chapter 12, we theorize the concept of transplatform relations, the idea that platforms cannot be considered in isolation even when they have distinct technological and social boundaries. We first show how rivalries with Atari and ColecoVision co-constituted Intellivision, then turn to the rise of third-party developers, work by Atari and Mattel Electronics to make cartridges for each other's systems, and finally the System Changer, an extension that brought Atari titles within Intellivision itself. The final chapter, "Crash," analyzes the end of Mattel Electronics and the second generation. At Mattel, indicators of the coming crash were largely ignored in favor of overextension—excessive and redundant effort that drained coffers, strengthened organizational silos, and fed confusion as to where Intellivision was headed.

The Age of Intelligent Television was a historical period formed by multiple intersecting forces, including the convergence of toys and technology, the rise of home computing, the emergence of second-generation videogames separating hardware and software, the ubiquity of television as a technological and cultural force, and tension between the arcade and the home as locations for different experiences of interactive play. Like many other videogame platforms from the era, Intellivision responded to this social, cultural, and technological matrix in distinct ways. We follow Intellivision's journey through this exciting and chaotic time, examining how engineers, programmers, managers, executives, and marketers navigated the blue skies of the early videogames industry, creating a platform that embodied the age while shaping the future of the industry and videogame culture.

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Formations

I

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From Toys to Technology at Mattel

1

Why did a toy company famous for Barbie and Hot Wheels end up making Intellivision? At first glance, toys and sophisticated computer technologies might appear to be at odds. However, Mattel integrated technology into its products from the beginning, thus fundamentally transforming the toy industry. Tracing Mattel's path from toys to digital technology illuminates why, despite the challenges and expense, Mattel executives eventually supported Intellivision. Intellivision appears not as an anomaly but as the culmination of Mattel's innovation as a toy company. This challenges the framework of videogame generations. While Intellivision is a programmable second-generation system, a danger of the generations framework is that the causal forces shaping home videogame systems are understood as solely internal to the domains of digital games and computing. But Intellivision was not just a response to rivalry with other home videogame systems like Atari, nor a direct descendent of first-generation games like *Pong*. Intellivision was also a story of toys and play influencing technological transformation.

Southern California

From its founding and throughout Intellivision's history, Mattel was located within the greater metropolis of Los Angeles. California occupies a special place in a history of technology typically associated with Silicon Valley, located in Northern California. Just utter the phrase "Silicon Valley" and multiple images come to mind, like Steve Jobs and Steve Wozniak, or

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William Hewlett and David Packard, founding computer companies in a garage. Even Atari was established in Northern California.

Silicon Valley gave rise to what scholars call a "Californian Ideology" that "promiscuously combines the free-wheeling spirit of the hippies and the entrepreneurial zeal of the yuppies."[1] In the book *From Counterculture to Cyberculture*, Fred Turner explored how "an extraordinarily influential group of San Francisco Bay area journalists and entrepreneurs" shaped Silicon Valley, resulting in "a complex intertwining of two legacies: that of the military-industrial research culture . . . and that of the American counterculture" which "helped to synthesize a vision of technology as a countercultural force."[2] Yet, despite Silicon Valley's fame, there is not a single "Californian ideology." Referencing Silicon Valley and similar regions, AnnaLee Saxenian developed the notion of a "local industrial system" to address how many companies are located in geographies larger than a city but smaller than a state.[3] A local system is "based on a social organization that by and large shares a work culture and instrumental goals aimed at generating new knowledge, new processes, and new products."[4] Centered on Los Angeles but extending north to Santa Barbara and south to the Mexican border, Southern California—where Intellivision was born—represents a distinct local industrial system with a "Californian ideology" just as important for the history of technology.

Southern California shares with Silicon Valley a pervasive military-industrial complex, mediated through defense contracting with companies founded or significantly present in the area (including North American Aviation, Raytheon, Rockwell, and TRW). Staff from these companies were often connected to universities like Caltech, UCLA, and USC, and from that background they brought skills and worldviews reflecting longstanding relationships between the military, technology, and culture.[5] These connections were particularly evident with regard to the Jet Propulsion Laboratory (JPL), the NASA field center located in Pasadena. Yet Southern California also has a rich history combining art, technology, and design—for example, with the Art Center College of Design, also in Pasadena, and the California Institute of the Arts (CalArts). Many engineers and artists who developed Intellivision came from these worlds.

Unlike Silicon Valley, Southern California's intersection of technology, culture, and consumerism focused on entertainment, where a culture industry of motion pictures and television gave Hollywood near-mythic status.[6] Engineers, artists, and entrepreneurs developed innovative technology to deliver entertaining dreams to the nation and world. Mattel was shaped within this crucible, and Mattel Electronics, the division that developed Intellivision, would maintain important connections to Hollywood.

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Some of these were explicit, like developing videogames based on the movie *Tron*. Other relationships were less visible, including voice actors for Intellivoice titles (chapter 9) and videogame manuals authored by screenwriters.

Within and alongside Hollywood, another crucial intersection of technology, consumerism, and entertainment has been the Walt Disney Company, founded in Burbank in 1923 and eventually including Disneyland, which opened in Anaheim in 1955. In part, Disney transformed the Southern California local industrial system by commodifying storytelling, play, childhood, and simulated realities. Disney's emphasis on technological innovation is encapsulated in "imagineering," a concept that was not invented at Disney but trademarked by the company and used there from the 1960s. Imagineering combined creativity and the practical expertise of engineering. Echoes of this would appear years later in the notion of "Concept Engineers" used within Mattel's research and design (R&D) culture and reflected in Mattel Electronics' recruitment materials that described the company's goal to "transform The Creative Idea into a finished product."[7] Throughout Mattel's history, Disney functioned as both an occasional business partner and an aspirational image for Mattel's leadership.

Perhaps because of its relationship to entertainment, fantasy, and consumerism, Southern California has been portrayed as shallow and inauthentic. Yet, such superficiality is not without its own relationship to intellectual depth. For example, in the decades leading up to Intellivision, this mediated "intelligence" took its most classic form in the noir novels and movies that represented "some of the most acute critiques of the culture of late capitalism" and that "made Los Angeles the city that American intellectuals love to hate."[8] The integration of technology and Southern California noir is exemplified by *Blade Runner*. For this film—released in 1982 at the height of Intellivision's boom—director Ridley Scott moved the San Francisco location of the original novel to a dystopian Los Angeles.[9] Yet despite its reputation of unserious frivolity, Southern California has also fascinated intellectuals, from the post–World War II influx of Frankfurt School theorists like Max Horkheimer and Theodore Adorno (who wrote *Dialectic of Enlightenment* while in Los Angeles) to French theorist-residents like Jean Baudrillard, Jacques Derrida, and Jean-François Lyotard, all fascinated by Los Angeles's simulated hyperrealities.[10]

Southern California's local industrial system would deeply shape Mattel as a place and community of practice. It also shaped Intellivision itself. For example, the system was costly and complex because its development was led in part by an engineer migrating from aerospace, unfamiliar with the cost-cutting priorities of a toy company. Yet this machine—created by engineers and industrial designers—would be given life through Mattel's

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marketing magic, transformed through advertising into a product promising sophisticated entertainment and captivating realism. In 1933, a few years before Mattel's founders moved to Los Angeles, one observer concluded, "Los Angeles, it should be understood, is not a mere city. On the contrary, it is . . . a commodity; something to be advertised and sold to the people of the United States like automobiles, cigarettes and mouth wash."[11] Indeed, Mattel's creations were not mere toys but products to be sold, marvels of play and technology marketed into the minds of millions of consumers. This would be Intellivision's destiny as well.

Barbies and Burp Guns

In 1935 Ruth Mosko left Denver for Los Angeles, to be joined by husband-to-be Elliot Handler, who took work as a lighting fixture designer at a company where Harold "Matt" Matson was the foreman and a friend. At home, Elliot began making lamps, picture frames, and other household items from Lucite, a novel material at the time. By 1939 Ruth, Elliot, and Matt began "Elliot Handler Plastics," with Ruth in charge of sales. Their first major contract was for plastic jewelry pins, and the company was renamed "Elzac" due to a partnership with the jewelry designer Zachary Zemby ("El" from Elliot + "Zac"). In 1941 Ruth and Elliot's daughter, Barbara, was born. Matt left Elzac in mid-1944. Using Elliot's designs and with Ruth in charge of sales, Matt began making picture frames in a garage—a story of entrepreneurial origins that is "a venerable California tradition" in the technology industry.[12] The next month Ruth, Elliot, and Matt founded a new company, Mattel Creations, later called simply "Mattel" ("Matt" + "El"). Elliot left Elzac in October 1944 and started making dollhouse furniture from Matt's picture frame scraps, and Mattel pivoted to toys.[13]

The integration of toys and technology was crucial to Mattel's early success. Elliot had a knack for toy design and basic engineering, attending the Art Center School in Pasadena (before it became the Art Center College of Design). As bestselling author Robin Gerber noted, before Barbie and Hot Wheels "it was the musical toys that grew from Elliot's boundless imagination that put Mattel on the toy-company map."[14] Initially, these were toy instruments like the Uke-A-Doodle from 1947 (riding the popularity of Arthur Godfrey's radio shows) and then a toy piano. Later, Mattel designers embedded toys with "a small box with tiny wires that were plucked when a crank was turned," thus playing a tune under a child's control.[15] The toy music box was conceived by Ted Duncan, who worked in the music industry and also arranged music for films. Duncan wanted to make a cheaper Swiss music box for toys and approached Mattel in the late 1940s. Paul Blair,

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a Black engineer and foreman for Mattel's factory, reworked the design, which ultimately caused a falling out with Duncan.[16] According to the patent, Blair created "a music producing unit which is adaptable to play substantially any tune desired and which can be adapted for use in connection with a great variety of musical toys."[17] "And boy, did we ever adapt!" wrote Ruth, explaining that Mattel "came up with dozens of new music-making toys" including a musical clock, crib, and jack-in-the-box.[18] Mattel updated the Uke-A-Doodle with a music box and advertised it on the packaging as "Two Toys in One," emphasizing the toy's hybridity and technical integration. While Blair's adaptable mechanism might appear to be a simple innovation, it signified the company's embrace of experimentation, technologization of toys, and iteration around a mechanical platform. As we note in the introduction, this "Mattelism" model of "toy platform capitalism" meant that the company had a preexisting framework for product development that anticipated electronic games, including videogame systems.

Mattel's technical experimentation with toys quickly expanded. Around 1955 Jack Ryan joined Mattel, playing a crucial role in toy design, eventually including Barbie. Ryan had been a design engineer working on a missile system for Raytheon in Southern California and learned of Mattel during test-firing trips north of Los Angeles.[19] The integration of toys and technology became further entrenched under Ryan, with Mattel releasing a water-propelled missile in 1958 and an electromechanical game called Sonar Sub Hunt in 1961. The Mattel engineer (and later manager) Gene Kilroy emphasized that "Ryan brought aerospace-grade R&D to the toy business," adding that "Mattel, long before Intellivision, was inventing and showing things that shocked all the toy companies in New York . . . It was technology that the toy industry had never seen." By 1962 Mattel had "200 toy developers, including chemists, sculptors and engineers" in their factory, and Ryan touted to *Time* magazine, "We're right out on the frontier of technology."[20] In the wake of Ryan's influence, "Mattel had the trappings of a major aircraft company, with its own research and development department and twenty graduate engineers with a large budget to dream up the next hot toy . . . they were called the blue-sky group, and they were expected to think two to four years into the future."[21] "Blue sky" reappeared to describe brainstorming toys and videogames. As noted in the Introduction, the journalist Howard Polskin used it to call Intellivision programmers the "Blue Sky Rangers," a phrase they informally adopted.

Around the time Ryan was hired, Mattel fundamentally altered the relationship between toys and television. By 1954 Mattel was specializing in toy musical instruments and toy guns, with annual sales around $4 million, while the entire industry had sales of less than $1 billion; Marx Toys, the

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biggest company, made about $50 million a year.[22] Toy companies worked through wholesalers or "jobbers" and had small advertising budgets.[23] In his book *Children's Television: How It Works and Its Influence on Children*, Cy Schneider recalled that in 1954 the founder of Marx Toys "boasted that he had spent only $312 in advertising. He maintained that advertising did not and could not sell toys."[24] Schneider managed Mattel's small account within the advertising agency Carson/Roberts, and in mid-1955 ABC contacted the agency about a new television show, "The Mickey Mouse Club." This Disney-produced show looked like it would be a hit. However, Disney was charging $500,000 to sponsor fifteen minutes of the show once a week. This was an unheard-of expense in an industry where advertising was basically nonexistent. It represented Mattel's entire net worth at the time, but Ruth was taken with the show's potential, as was Elliot (who had worked briefly at Disney). "Within an hour" they agreed to the proposal, the only toy company to do so.[25] Carson/Roberts and Mattel created a commercial for the new Burp Gun toy. Thus, starting November 1955, "every Wednesday from 5:30 to 5:45, 90 percent of the nation's kids were watching the first toy commercials ever put on film."[26]

To call the commercial a success would be a massive understatement. By Christmas over one million Burp Guns shipped, matching Mattel's $4 million total revenue the previous year.[27] As a result, "Mattel's decision to advertise toys to children on national television fifty-two weeks a year so revolutionized the industry that it is not an exaggeration to divide the history of the American toy business into two eras, before and after television."[28] It also changed the way Mattel viewed toys. Schneider wrote that they "began to see toys as concepts that could be depicted or demonstrated in television commercials . . . Presenting the product on television became part of the product."[29] More complicated toys like Sonar Sub Hunt could now be shown to kids and parents on television—instead of languishing on shelves because they confused consumers—an innovation which would ease the introduction of sophisticated technical toys including, in the future, Intellivision.

Flush with toy guns in the late 1950s, Mattel sought a girl's toy to balance their offerings. The result was Barbie, which launched in 1959. Ruth encountered the "Lilli" doll in a shop in Switzerland and bought one for Barbara. In a second shop, Barbara saw another Lilli wearing different clothes. Ruth asked the clerk, "Could I buy an extra outfit for Lilli? . . . I got the 'you-stupid-American' look and the retort that if you want the outfit, you buy the doll wearing it."[30] This inspired the revenue model central to Barbie's success. As Ruth explained, "Sell the razor at a reasonable price and people will buy the razor blades—or clothes, in our case—to go with it."[31] Tom Kalinske, Senior Vice President of Marketing and later President of Mattel,

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recalled that managers at Mattel "used to openly talk about that 'razor/razor blade' kind of model." Elliot himself was quoted in *Time* magazine: "Buy the doll and then you buy the clothes. I know a lot of parents hate us for this, but it's going to be around a long time."[32] Profits came from items ranging from clothes to campers, perhaps influenced by Elliot's original sales of doll furniture for doll houses. These Barbie accessories, and even Blair and the Handlers' adaptable music box, reveal how molded plastic bodies and mechanisms could operate as "platforms" for a variety of products.[33]

In 1960, Mattel's innovative work with musical toys, dolls, sound technology, and television coalesced with Chatty Cathy, a doll containing a small phonographic record with a pull string mechanism used to randomly play one of eleven phrases. While embedding records within a doll had a long history—even Thomas Edison had produced such novelties—Chatty Cathy added random expression and pioneered the use of a Hollywood voice actress, June Foray, to record interactive play elements like "Please change my dress." Created by Ryan, Chatty Cathy was in part a spiritual successor to Mattel's crank-operated musical toys from the 1950s and revealed the impact of television on toy design. Mattel marketing researchers found that talking "made her more attractive on television" but "was relatively unimportant after the doll was purchased."[34]

The talking mechanism was adapted to other toys. Charmin' Chatty allowed consumers to insert different records into the doll's back, selecting themes around shopping, a birthday party, or learning foreign languages. Mattel even released board games for Charmin' Chatty, with the records containing randomly spoken moves, thus allowing a child to play a game with the doll (figure 1.1). Charmin' Chatty was followed by the Mattel-O-Phone in 1965, which also used exchangeable, miniature records to simulate phone conversations for children. Mattel packaged record collections (including Snoopy, Charlie Brown, Barbie, and Disney) to be purchased separately. Similarly, Instant Replay (1970) allowed users to listen to reconstructed "replays" of memorable moments in sports. The toy came with four mini-records with images of famous sports stars such as Willie Mays and Bart Starr. Like the Mattel-O-Phone, Mattel released four-disc collections to cover different sports. The board game Talking Football (1971) iterated again on the phonographic mechanism. One player chose a small plastic record for an offensive play, and then another player chose from six defensive formations listed on the other side of the record, inserting the disc into a mechanism in a particular direction to trigger a sportscaster announcing the result of the play. Even in later years, the Teach & Learn Computer (1981)—an educational toy marketed to children—used interchangeable records with a touch interface that integrated electronics.

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1.1 Charmin' Chatty game box, with changeable records logo at bottom.

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While Mattel's history of toy production might suggest unfettered exploration, closer scrutiny reveals patterns and iterations around technical structures. Ruth once noted that developing Mattel's early music box led to a recurring principle: "If you develop a basic mechanism or a basic concept, you develop one or two or three items around that concept at the initial introduction, and then year after year you add new products around the initial concept."[35] These "principles," as they were called within Mattel, were akin to platforms for toy production.[36] Technical structures like miniature records were adjusted for different toy designs. The razor/razor blade model—appearing in toys such as Barbie, Charmin' Chatty, and Instant Replay—elaborated on this principle, splitting the underlying structure from its accessories to be "sold separately." Redressing Barbie to change her look or inserting a miniature record into an analog device to change its output are technically simple compared to later developments like inserting a cartridge into a digital videogame system. However, they align conceptually. Mattel's embrace of such design principles, along with a robust R&D culture, prepared the company to further explore the integration of toys with technology.

Misguided Optimism and the Optigan

"You can tell it's Mattel, it's swell!" ran the toy company's famous slogan, and indeed all was swell as Mattel ballooned in the 1960s on the heels of hit toys like Barbie and Chatty Cathy, becoming a Fortune 500 company in 1965. The company had further success with their Hot Wheels cars, introduced in 1968. In 1969, Ruth moved to divisionalize the company, explaining that "we would set up three toy divisions: 'Dolls,' 'Wings and Wheels,' and 'Toys.'"[37] This would allow the divisions more freedom to experiment and expand. While making a videogame system a decade later would be a new challenge, there was precedent for "Mattel Electronics." Mattel was already familiar with the idea of setting up quasi-independent divisions oriented around specific product categories.

Josh Denham, who later became President of Mattel Electronics, explained that "Ruth was very ambitious in making the company bigger, but there was a limit to how big you could make the toy business." To spur growth, the Handlers hired a new Chief Financial Officer, Seymour Rosenberg, who had worked for Litton Industries, "a company made rich through related but autonomous divisions and aggressive acquisitions."[38] With Rosenberg onboard, Mattel began its own acquisitions, and due to antitrust laws these could not be other toy companies. Acquisitions included Barnum & Bailey Circus, the pet supply company Metaframe, and

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Monogram Models. The Handlers thought diversification could "cushion the shocks of the volatile and seasonal toy business."[39] Diversification was also driven by "the Handlers' vision of a company that sold not just toys, but fun, in its many money-making varieties. 'The World of the Young,' as Elliot and Ruth called their grand ambition, rang of Disney."[40] Mattel even created a film production company, Radnitz/Mattel Productions, that released six movies between 1972 and 1977 and "was meant to challenge Disney's supremacy in children's movies."[41]

Mattel's Optigan, released in 1971, aligned with this desire to grow and diversify, foreshadowing Mattel's more pronounced move into electronics in the late 1970s. On the heels of the Chatty dolls, Elliot "turned his attention to his Uke-A-Doodle roots" and became enthralled with producing an electronic toy organ that any consumer could play.[42] Conceptually, the project extended Mattel's history with musical toys and changeable sound media but was more sophisticated technologically.[43] Indeed, Mattel formed a subsidiary company to enlist additional personel and market the product. The Optigan read prerecorded music from transparent, optical discs the size of long-play records, each containing different musical genres and forms, such as "Latin Fever" or "Guitar in 3/4 Time." The left side of the instrument contained a keypad used to select a repeating musical track from the record and features like changing the track's musical key. On the right, a traditional keyboard allowed notes to be played over the prerecorded music. Thus, the Optigan was an early music "sampler," using real music encoded on the discs. While originally conceived as a toy, it evolved into "a kind of instrument adults could enjoy," thus expanding Mattel's business beyond toys.[44]

Like Intellivision, the Optigan was complex and expensive compared to other Mattel products, retailing for $200–$400.[45] It did not capture the consumer's imagination and suffered from technical problems, leading to a $6.5 million loss.[46] It was seen by some as the primary cause for Mattel's significant downturn in fiscal 1973, leading to Ray Wagner replacing Ruth as President of the Toy division and Art Spear replacing Ruth as President of Mattel.[47] Elliot and Ruth remained on the board of directors as co-chairs. In addition to the Optigan, which Ruth called a "major disaster," all was not swell at Mattel in the early 1970s. The company experienced several setbacks including slowing sales with Hot Wheels and difficulties with some acquisitions.[48] To keep stock prices high, placate shareholders, and hide the growing losses, Mattel engaged in a suspect practice known as "bill and hold," in effect selling inventory the company had not yet made and marking it as held in a warehouse. Mattel's financial leadership could declare profits earlier in the fiscal year before actual sales (many of which were canceled).

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This subterfuge led to a Securities and Exchange Commission investigation and the departure of Elliot and Ruth in 1975.[49]

In hindsight, the Optigan project contributed significantly to the storm that nearly consumed Mattel—and bankrupted Barbie—in the early 1970s. It was emblematic of the Handlers' desire to step beyond toys but also their failure to do so effectively. While the Optigan experience tempered management's ambitions when it came to high-tech projects, its failure would not kill off technical experimentation with toy design. Nor would it prevent Mattel executives from dreaming of growing beyond toys, fueling a similar boom and crash with Intellivision a decade later.

Life on the Funny Farm

Even as Mattel experienced challenges in the early 1970s, the fundamental engine of toy development continued. A unique framework for R&D was established, developed from Elliot Handler's focus on toy design and Mattel's strong support for research. By 1969 multiple R&D groups had coalesced into what was known as Preliminary Design. Many foundational ideas behind Preliminary Design came from Ryan's experience at Raytheon, including an obsession with secrecy. By the early 1970s, Preliminary Design was a single entity located on the third floor of the Mattel headquarters in Hawthorne, California, next to the 405 freeway.[50] This was the only secure floor that required special authorization to access (including badges with red dots). Staff from other divisions were forbidden. The programmer Rick Timmins recalled how Mattel even "recorded people on the freeway trying to take pictures through the windows."

Preliminary Design—known affectionately as the "Funny Farm"—was infamous for freewheeling informality and pranksterism. Within its walls, teams were given freedom to invent. Derek Gable, who helped manage the group, emphasized that "it was Elliot's brainchild to set up a separate research think tank, mainly to protect us from the marketers. Because if they could see what we were doing, they would have freaked out and fired us all." Gable noted that the "Funny Farm" was the engine of Mattel's business: the company would hire "creatives" and "give them a playground and leave them alone." Here, work and play blurred, an early form of playbor. The creative visions of the "freaks," as Gable called them, were harnessed by the "suits," suggesting that toy companies like Mattel were instrumental in the rise of cultivating and managing playbor long before the term was used to discuss work within the videogame industry. The term "funny farm" mingles the fun of toys with the eccentricity of creatives who were locked away as if in an asylum. Fun was farmed, and play value was extracted,

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packaged, and sold. But Joe Whitaker, a Vice President for Marketing, noted the relationship was also collaborative. "Marketing and Preliminary Design worked together," Whitaker said, "They were the creative geniuses coming up with the ideas, but we were the ones who through all our market research were best positioned to say, 'We think that will sell.'"

After initial meetings with marketers, designers were largely left alone to develop their blue sky ideas with less concern for viability or cost. As the Program Manager Jerry Frazee emphasized, "They're not designing anything that actually works. They're coming up with a design concept." Every Wednesday, a "product conference" would be held with senior executives like Elliot Handler or Wagner. Kilroy, who became a Director in Preliminary Design, noted this was where designers "presented things that were at the beginning. It could be a concept sketch, it could be a model, could be a prototype, could be a breadboard." If there was support, later meetings known as "turnover meetings" and "takeover meetings" would take place. The former emphasized viability in terms of cost and sales potential. In the latter, the concept would be handed over to the Product Development division, which would turn it into a marketable product.[51]

Preliminary Design was firmly established by the mid-1970s, when Intellivision was about to be conceptualized and developed. It had six directors, each leading teams with a particular product specialization.[52] Richard Chang, who had been Team Leader for developing the Optigan, became Chief Concept Engineer in charge of electric toys and new inventions in 1972, managing a team of five.[53] Chang initially studied engineering at Chaffey College in Southern California before receiving a B.S. in Mechanical Engineering from UC Berkeley, where he also did graduate work in aeroscience. He was not yet a citizen when Ryan hired him in 1962 as an "experimental engineer" analyzing "production problems for the first talking toys."[54] Working in Mattel's Acoustics Laboratory beginning in 1964, Chang became known as a brilliant designer, eventually holding many patents, several with Ryan.[55] Kilroy would later call Chang "the best toy inventor in the world," known for innovative thinking but also a practical emphasis on cost control and feasibility.

Chang moved into Preliminary Design in 1969. While working on sound-related projects such as the Chatty toys and the Optigan, his team also designed memorable toys like the Vertibird helicopter and Mattel's SuperStar toy airplane (the first mass-produced, electrically powered toy airplane). Kalinske emphasized that "Richard was one of the first guys to suggest putting some kind of electronic mechanism—not a pull string, not the records device—rather electronic chips in the dolls and have them create the voice from a memory chip." Chang imagined electronic technology extending

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the mechanisms found in earlier toys. His team even conceptually extended Mattel's record-playing mechanism, using a similar idea to "program" Mattel's electric toys: notched, plastic discs inserted into the SuperStar toy airplanes and cars would control their movements. One patent that included Chang described the SuperStar airplane as a "programmable free-flight toy aircraft."[56] Despite having been Team Leader for the failed Optigan organ, in 1975 Chang was promoted to a Director of Preliminary Design in charge of "new venture products, electronic toys, technical products, and radio control toys."[57]

Gable explained that back in the early 1970s, electronics "wasn't integrated into the toy industry. It wasn't a toy. It was something different." Toys and consumer electronics were seen as separate businesses. Yet, just as the Handlers decades earlier had combined their successful Uke-A-Doodle with a music box mechanism to create a new product, within the creative corral of the Funny Farm experimenting with electronics and toys would lead to their merger. It was within Chang's group that the ideas for portable electronic games and Intellivision would evolve.

Calculators, Caltech, and APh

On January 26, 1976, David James, an industrial designer who began working in Preliminary Design in 1974, wrote a memo titled "Electronic Game Concepts." It listed two types of games, "Category 1—Video (CRT) Type w/Microprocessor Programming" and "Category 2—Calculator Type Games" (figure 1.2).[58] The first concept involved a "basic control console and interface w/ openstock 'plug-in' game programs in form of cassettes," the essence of a second-generation system and the idea that would eventually become Intellivision. In the memo, the console discussion comes first and is far more detailed than that of "Calculator Type Games," which lists only a few game ideas. By 1976, Chang's group in Preliminary Design was contemplating two different product concepts. What brought them to this point? Put simply, consumer calculators and *Pong*.

On the heels of its financial problems, Mattel hired Michael Katz as Marketing Manager for New Product Categories in 1975. Katz's parents both worked for Macy's, and growing up he fell in love with merchandising and the creative aspects of marketing that drove sales. At Mattel, Katz was tasked with pursuing entirely new product categories and strengthening weaker areas in Mattel's toy line (like games and toy trucks).[59] While Mattel had produced board games in the past, even for adults, Katz recalled that other companies dominated the category. Katz explained that "there were no groups specifically for new product categories, but there was a group

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DATE: JANUARY 26, 1976

BY: DAVE JAMES

RE: ELECTRONIC GAME CONCEPTS

CATAGORY 1 – VIDEO (CRT) TYPE W/ MICROPROCESSOR PROGRAMING

1. MARKET BASIC CONTROL CONSOLE AND INTERFACE W/ OPEN STOCK "PLUG-IN" GAME PROGRAMS IN FORM OF CASSETTES OR MODULE R.O.M.
2. FOOTBALL – 10 PLAYERS EACH SIDE PREPROGRAMED FOR 6-12 DEFENSE/OFFENSIVE PATTERNS – PLAYER CONTROLED RUNNING BACK & DEFENSE BACK – FLOATING FIELD BACKGROUND – ON SCREEN SCORE, DOWN, YDS TO GO & CLOCK
3. GRAPHICS DESIGNER- COLOR – VIDEO "ETCH-A-SKETCH"
4. ALPHA-NUMERIC FOR READ-OUT RESULT- STRADAGY GAMES
5. TYPICAL BOARD GAME APPLICATION – CHECKERS, CHESS
6. GAMBLING GAMES – SLOT MACHINE, BLACK JACK, ROULETTE, ETC.
7. WAR GAMING
8. DRIVING SIMULATOR – RALLYE & RACING
9. VIDEO PIN BALL

CATAGORY 2 – CALCULATOR TYPE GAMES

1. DEVELOP CUSTOM X,Y MATRIX LED BUILDING BLOCK
2. CAT & MOUSE CHASE GAME
3. PIN BALL

1.2 "Electronic Game Concepts" memorandum (by David James).

that got a lot of stuff that was electric or electronic, led by Richard Chang." In a meeting with Chang about new product ideas for 1976, Katz recalled that the "hottest consumer product" for electronics "at a reasonable price point" was the electronic portable calculator, and "so I said to Richard, 'Let's do an electronic game the size of an electronic calculator with LEDs. Build me a prototype.'" Such a product would strengthen Mattel's position in games while developing a new category.

Members of Chang's group imagined grander possibilities than calculator games. James remembered Larry Sims, who first worked for the Aerospace division of General Motors designing jet engines and countermeasures on weapon systems, first suggesting the idea of developing a videogame system using the television in 1975. Sims recalled:

> I had seen the *Pong* game out in bars and stuff. And I naively thought, "Why couldn't we do a product where we connect to a television set

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> and do it with better graphics?" And instead of a little block moving around, have them look like football players and baseball players and race cars and things like that. And so I started talking to people in the group. Dave James was there, George Klose of course.

Atari's *Pong*, a "table tennis" arcade game where players bounce a ball between paddles, appeared in 1972, and Home Pong, a version for televisions, arrived in 1975. By the mid-1970s, it was evident that videogames "would play a significant role in the future of the toy industry," but "designing the games remained beyond the expertise of most toy companies, and the risk of failure with such an expensive offering proved daunting."[60] However, Mattel had a robost R&D culture. Having worked on the Optigan, Chang understood the risks, but he also understood Mattel's potential to innovate and the possibility to collaborate outside Mattel. Chang's group began to do their research.

Sims recalled that James, Klose (an engineer in Preliminary Design who was a Holocaust survivor), Chang, and other members of Preliminary Design attended seminars held around Southern California showcasing emergent technologies. Some of these seminars featured microprocessors—chips designed for smaller computers. In fall 1975, MOS Technology's 6502 chip entered the market. The chip was inexpensive so as to have wide potential in consumer markets and to compete with Intel microprocessors. The 6502 would become hugely popular, with versions appearing in videogame systems and home computers from the Atari VCS to the Apple II and the Nintendo Entertainment System. In late 1975 or early 1976, Chang and Klose became aware of the 6502 and arranged a meeting with MOS Technology.

This meeting proved significant for several reasons. Foremost, it was where Chang met Glenn Hightower. Hightower did not work for MOS Technology but was acting as their agent and consultant. Hightower had recently founded APh Technological Consulting, a company that would become instrumental to Mattel's success with both its handheld games and Intellivision. Hightower graduated from Caltech, and APh was named after Caltech's Applied Physics major. Located in Pasadena, "Caltech was no mere ivory tower, but the dynamic nucleus of an emergent technostructure that held one of the keys to Southern California's future."[61] Caltech was thus a pivotal Southern California local industrial system institution: "Nowhere else in the country did there develop such a seamless continuum between the corporation, laboratory and classroom as in Los Angeles, where Caltech via continuous cloning and spinoff became the hub of a vast wheel of public-private research and development."[62]

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Hightower had worked for several faculty members while at Caltech, and after graduating picked up additional clients in several other departments and outside Caltech. Eventually he taught for Caltech, including a class on microprocessors in Fall 1975, which is how he met a representative from MOS Technology to acquire chips for his class. Early APh projects included working for the company Accutoll on credit card security systems and a contract with Robert Abel Films for which APh designed a camera control system using the Fairchild F8 microprocessor. Almost all of APh's technical employees were former or current Caltech students. This included John Denker who became a partner at APh, and Shal Farley, who recalled that it was Denker "who got me playing with computers."

MOS Technology contacted Hightower to facilitate a 6502 demonstration for Mattel, which would take place in a hotel conference room. Hightower recalled that MOS Technology "needed somebody to talk about the application of microprocessors to video games." Hightower brought an Applied Data Systems (ADS) terminal, a Ball Manufacturing Company monitor, and some breadboard circuitry to the meeting, demonstrating turning cursors into moving objects like ships, bullets, and players.

After the presentation, Klose and Chang remained to talk with Hightower without the MOS Technology representatives present. Chang described an idea for a videogame system that could allow consumers to play football. This meant the ability to have twenty-six moving objects (eleven players for each team, three referees, and the football)—far beyond the capabilities of any videogame system of the time. Soon after this meeting, James wrote the memorandum proposing two kinds of electronic games, the calculator games and the programmable system (figure 1.1). One of James's proposed ideas for the latter category was "Football—10 players each side preprogrammed for 6–12 defense/offensive patterns—player controlled running back & defensive back."[63] This echoes the vision for a football videogame that Chang related to Hightower.

At the meeting, Chang did not mention calculator games to Hightower. However, several weeks later Hightower received a call from Klose, who worked for Chang, asking Hightower for assistance with a circuit. Mattel had received equipment at the meeting with MOS Technology, including a Keyboard Input Monitor (KIM) to use with the 6502. Klose was having difficulty attaching an array of LED lights to the KIM board for prototyping an electronic game. Eventually, Klose and Chang asked Hightower if APh could assist with the project. Klose gave Hightower the KIM board—and a few pages of 6502 assembly code, which Hightower scrapped—and APh began work on the prototype. Mattel's idea for a programmable videogame system

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was temporarily put aside while Chang's group moved forward developing handheld games.

During Mattel's financial troubles and after the Optigan debacle, Katz said there were two political camps—those "who thought Mattel should just stay a doll and Hot Wheels and toy company" and those who were "for completely new stuff." Katz walked a tightrope between the two, as did the idea for electronic games inspired by consumer calculators. Such electronic games were radically new but also safe, reminiscent of pocket radios and portable toys. Mattel executives had been noting the growing market for portable electronics since the early 1970s, when Fred Held, Chief Information Officer at Mattel, nearly signed a deal with the Japanese company Seiko to sell pocket FM radios. Indeed, Mattel's Instant Replay toy (1971) was modeled on a portable transistor radio. Unlike a complex videogame system with cartridges—recalling the failed Optigan—the idea to repurpose calculator technology for a toylike electronic game made sense.

Handheld Games and Mattel Electronics

Mattel invented the product category of handhelds. They originally were called "portable electronic games" and typically sold for between $25 and $35. They were battery operated and represented basic game actions using a grid of LED lights placed within a small display surrounded by a larger plastic casing. *Auto Race*, the first handheld manufactured, used three columns of seven LED lights each to represent the race track (figure 1.3). A player would hold the game in hand, using buttons to control a race car by "moving" an LED light around the grid. Slightly smaller, dimmer lights would appear at the top of the grid and move down the columns, slow or fast depending on the car's speed, which was selected by the player. The player would avoid colliding with these obstacles by moving their car out of the way. Chang's group settled on auto racing and football as initial games to develop in part because the simple LED technology facilitated gameplay based on avoiding obstacles.[64]

APh assisted with the development of prototypes. David Rolfe, soon to be hired as a programmer at APh, remembered Denker and Hightower working in the corner of the Caltech computer lab: suddenly, the distinctive "tweet, tweet" sound of the handheld *Football* videogame would blurt out and "everybody would stare at them."[65]

However, Mattel executives remained skeptical, in part due to memories surrounding the failed Optigan organ. Marty Miller, Director of Marketing Research for Mattel Toys, remembered Wagner asking, "Who's gonna pay $29.99 for a handheld game, this little calculator thing?" Kilroy recalled

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1.3 *Auto Race* handheld game (casing design by David James).

marketing executives protesting: "'How can we be asked to sell this little thing that moves red dots on it for $25 and up when I can buy a handheld calculator for $15?' When you have an innovative toy, you don't have a benchmark to compare it to." Despite these concerns, Mattel executives decided to put the handhelds into production.

Chang's team finalized the housing and circuitry with the help of APh. By mid-1976, they were negotiating with Rockwell International to convert 4-bit chips developed originally for calculators for the handhelds.[66] Rockwell was a military contractor with a major presence in Southern California. As Rockwell's chips neared production, James remembered Wagner originally asking for a requisition of only 20,000 for *Football*, inquiring what penalty fee Rockwell would charge if Mattel did not take the full shipment. Despite uncertainty about the product's viability, a larger order was planned. Fred Held met with Rockwell staff and "in a Chinese restaurant,

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on the back of the doily, I placed the big order." At Rockwell, Mark Lesser programmed the first handhelds, *Auto Race* and *Football*, using game specifications from Klose.[67] As James described it, Klose "wrote the protocols, the flow charts and all that kind of stuff. And then [Lesser] put the ones and zeros together." This was no mean feat. Lesser wrote the code for *Auto Race* and *Football* "using punch cards in a minicomputer" and with only 511 bytes of memory each.[68]

With expertise in modeling as well as electronics, James was tasked with designing casing for the new products. Handheld production echoed Mattel's history iterating new toys around a mechanism. For Mattel Toys, handhelds were business as usual: engineers created gameplay variations with LED lights for different games. Katz noted, "The LED movement basically stayed the same: what made the games dedicated to particular sports was the housing." James recalled how "I sat down and thought, 'There's gotta be a better way to represent these games.' And I said, 'Ah!' And I drew it. It became known as the stadium concept. Up to that point marketing was saying, 'It's got to look like a calculator.'" This concept, with an oval "stadium" surrounding the LED screen, was presented at a turnover meeting. James recalled showing the model for *Football* at a long table, with Wagner at the other end: "He finally gets up and he walks around and he says, 'Let me have that. See this? I want to go with this, but I want to tell you guys, don't change anything. Don't change the shape, don't change the colors, don't change anything.' That had never, ever happened before."

While Chang's group built the handhelds, new management helped spearhead the production and marketing. In Fall 1976, Mattel Toys hired Ed Krakauer as Vice President of New Business Development. Krakauer explained that Mattel hired him to "stir up the pot," create new ventures after Mattel's troubles in the early 1970s, and diversify the company. Krakauer soon hired Jeff Rochlis as Director of New Business Development. Rochlis had graduated from Bard College with a degree in acting and had worked as a marketing executive for Nabisco.[69] Mitch Junkins, the Manager for Business Development at Mattel Toys, recalled how Rochlis was a consummate technology promoter (one magazine article at the time called him "brash and brassy").[70] With this new leadership Mattel Electronics began to emerge.

In early 1977, the consumer electronics industry was hyped about first-generation videogame consoles, as well as the arrival of second-generation videogame systems, home computers, and cable television. Toy-like calculator games were not on the radar. Miller said Mattel performed testing in the spring, typically in March, and once "we showed kids what the handheld games could do, the purchase interest was through the roof. So we knew we had a tremendous hit." Eventually, hundreds of thousands of handhelds

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sold, and Mattel Electronics "could not produce enough of these units in 1977 to meet the demand," especially during the Christmas season when *Football* became a massive success.[71] By late October the *Washington Post* reported, "At Hollywood Toys, the largest shop in Los Angeles, there are actually lines of people waiting to buy the Mattel Electronic [sic] Football game."[72] Mattel Electronics sold around one million units of *Football* and around two million handhelds total during fiscal 1978, translating to $30–$40 million in sales, nearly half the handhelds market.[73]

This success motivated formalizing Mattel Electronics as a division within Mattel. "Mattel Electronics" dated back to 1977, but largely as the "trademarked line name" on handhelds.[74] In 1978 Mattel Electronics began what Frazee called "a full break-off from the toy company. We had everything from president, marketing, finance, engineering, that was all separate. We operated like Buick and Pontiac."[75] To remain with Mattel Electronics, Rochlis insisted on the title of President. Krakauer agreed, and in September 1978 Rochlis became President of Mattel Electronics.[76] Junkins emphasized that Rochlis was a "big proponent" of separation because of a conviction that "you can't be a true gaming company if you're a toy company." The very name "Mattel Electronics" set the division apart from toys. In September 1978 Chang became founding Director of "Design and Development," a new department (inspired by Preliminary Design) that was dedicated to electronic games and products but entirely within Mattel Electronics.

In line with toy industry norms of the period and cultural assumptions about sports, the handhelds were marketed as boys' toys, thus establishing a gendered baseline for videogame consumers at Mattel Electronics. The "primary target audience" for handhelds was "males 8 to 17 years of age" and the secondary audience "males 18 to 49 years."[77] While handhelds were not exclusively a male domain—Held recalled a group of girls (including his daughter) playing them at summer camp, with blankets over their heads to make the LEDs more visible in daylight—marketing videogames primarily to males would continue at Mattel Electronics, a theme we explore further in chapter 4.

The unexpected success of handhelds taught a lesson about predicting the market for new product categories, and not only in terms of gender. The Marketing Analyst Jim Goldberger recalled Rochlis asking attendees at a company meeting to imagine concept testing *Football*: "'A real football game has players, and all this game has is little blinking LED lights.' A lot of the tried-and-true methods of concept testing just don't work when you're trying to invent a new product category." While handhelds partially fit the familiar toy framework, their success also presaged a new paradigm.

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Krakauer observed that handhelds "were being treated as an additional SKU [Stock Keeping Unit], like another toy, and my sense was that could only go so far." The next step would be Intellivision itself.

From Toys to Intellivision

To program the handheld *Bowling*, released in 1980, Mattel programmer Rick Levine first wrote a simulation in the Fortran computer language. Levine also helped program *PBA Bowling* for Intellivision, released one year later. He recalled, "I took the Fortran algorithm and massaged that for the Intellivision game." While Levine was engaged in this work, the programmer John Sohl was tasked to create sounds for *PBA Bowling*, but he kept hitting a brick wall: "All we could get out of the sound chip was 'ping,' 'ping,' 'ping,' and those aren't bowling sounds." Sohl then discovered that "Mattel had a little recording studio. They had a machine to cut master records because when they had the Chatty Cathy dolls, they had little plastic discs in there." The recording studio was rarely used at this point, but Sohl was able to use the equipment to record sound at a bowling alley, which helped refine the game sounds. When released, *PBA Bowling* became another innovative sports game for Intellivision. However, it also contained traces of the handhelds and Mattel's history producing technologically sophisticated toys.

A programmable videogame system might seem a radical departure from traditional toys. But given Mattel's history—developing electronic toys through R&D, adapting technical mechanisms to different thematic contexts, and pursuing projects like the Optigan—Intellivision appears less surprising. Intellivision would extend a long-familiar process at Mattel. Similar to adapting a music box to different toys or producing different "embodiments" of "Obstacle Games" (as Chang and Klose's patent for handheld games put it), Intellivision programmers would develop different videogames using the platform's affordances.[78] The musical box, Barbie, the Optigan, and handhelds also were material and technical platforms that supported creative exploration. Understanding Intellivision as radically distinct from Barbie, Charmin' Chatty, or the Optigan—including their razor/razor blade model of production—is the result of viewing digital transformations as ruptures. Yet, Intellivision's past indicates historical continuity with toy development and its technical experimentation.

Krakauer noted that because "Mattel was a toy company," at the management level "there was a great reluctance to move into electronics." As with Katz, Krakauer had arrived after Mattel's financial troubles in the early 1970s, explaining that in the wake of those troubles "the orientation was

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more toward manufacturing the tried and true then it was to new and relatively uncomfortable areas." While Mattel engineers envisioned a videogame system long before Atari released its Video Computer System in late 1977, by first developing handheld games Mattel's leadership opted for continuity with cheaper, portable toys, thus acclimating themselves to digital technologies and paving the way for Intellivision. Denham explained that "the momentum to do Intellivision really came from the handheld games." Through the handhelds, upper management experienced success with electronics, became enticed by future opportunities, and were more willing to fund an ambitious electronics project over time.

However, the nascent Mattel Electronics unit—not yet a division—moved forward with their programmable system in early 1977, even before handheld games were in stores and their massive success buttressed upper-management's support for what would become Intellivision. At the time, the mood for electronic toys and games was favorable, with projections of growth and a digital future of videogames and home computers dominating the horizon. In March 1977, Tom Murn, the editor of the esteemed industry publication *Playthings*, wrote a short editorial about the rise of electronic toys called "The Joy of Complex Things." In seeming half-lament, half-celebration, Murn wrote, "The world of toys is no longer for children only," musing that electronic games augured the intensification of a trend toward "more complex, sophisticated forms of play activity."[79] Murn's editorial was published the same month Mattel Electronics sought an engineer to manage their emerging videogame project, a project that would fundamentally embody a vision of complex, sophisticated play. Though not named Intellivision until the following year, Mattel Electronics' intelligent vision for the future was in motion.

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The Master Component

2

In the mid-1970s, Mattel wanted to develop an electronic football game. Home videogames were all the rage at the January 1976 Consumer Electronics Show (CES), with industry observers noting that toy companies were gearing up to enter the market, including Mattel.[1] "Everybody's Playing Games," declared a headline of an industry publication covering the event, highlighting first-generation products with sports themes—ping pong, tennis, squash, handball, hockey, and football.[2] Mattel Electronics engineers attended this show, and football topped the list of their game ideas for a programmable videogame system soon after CES (figure 1.1). Many products displayed at CES were variations of Atari's Home Pong, where players bat an electronic dot back and forth between two paddles on a television screen. However, Mattel's toy designers wanted to create something more exciting and sophisticated—a microprocessor-based system, with ideas for war and gambling games, board games, driving simulators, and football.

Mattel had released the electromechanical game Talking Football in 1971, which survived in Mattel's toy line throughout the 1970s, a remarkable achievement given the fast turnover of most toys. When Mattel designers focused on developing toylike handheld games in 1976 and 1977, football remained in the forefront of their minds. Michael Katz, Marketing Manager for New Product Categories, recalled that initial game ideas for the handhelds were simply "auto race, football, auto race, football, auto race, football." Testing these and other sports themes with focus groups led to a clear winner: football. The industrial designer David James also

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remembered kicking around ideas with the engineer George Klose about a football handheld game because auto racing was too simple and "we wanted something that was more strategic." Indeed, when the handhelds were entering production, "Mattel's President signed a confidential agreement in February 1977" with Ralph Baer and his collaborators for "Monday Nite Football"—a complex first-generation videogame that allowed players to plan and execute plays on the television display.[3] While this agreement fell through, the desire to create sophisticated sports games strongly influenced Intellivision's development, marketing, and success.

Indeed, the desire to develop more complex, programmable systems was spreading across the videogame industry. In January 1977, Gametronics—one of the first conferences for videogame developers—took place in Burlingame, California, just south of San Francisco. The event was headlined by Baer, who received a "Pioneer in Electronics Award."[4] Among hundreds of less-prominent attendees, David Chandler showed his prototype arcade game *Tank Squadron*. A picture from the conference proceedings shows Chandler—dressed in suit and tie, eyeglasses partway down his nose—demonstrating *Tank Squadron* to an interested onlooker and a news crew (figure 2.1). Its sophistication attracted attention. One observer concluded that "an extension of the design approach used in *Tank Squadron* could be applied to other games by separating the electronics into game dependent and game independent circuitry," leading to "a possible generalized cartridge based game design."[5] That is, *Tank Squadron* was moving in the direction of a second-generation system architecture with cartridges.

Chandler received a D.Sc. in Electrical Engineering from The Carnegie Institute of Technology in 1951. Soon after he began working for Autonetics (a division of North American Aviation) in Downey, fifteen miles east of Hawthorne, California, where Mattel Electronics would be based. At Autonetics, Chandler became chief engineer of the Standardized Space Guidance Division and helped develop the Minuteman missile guidance system. He left to found Chandler Business Machines, which contracted with Video Play International Corporation to create *Tank Squadron*.

About two months after Gametronics, Chandler responded to an ad seeking a Project Engineer "with experience involving the complete product cycle in the development of electronic video games."[6] Although unnamed, the ad was from Mattel. The term "video" signaled television games, not LED-based handhelds. Chandler's application stated, "Since my most recent experience has been the application of a microprocessor to a video game . . . it would seem that there is a particularly good match."[7] In late April 1977, Chandler joined Preliminary Design under Richard Chang and took over responsibilities for developing Mattel's programmable videogame system.[8]

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2.1 David Chandler demonstrating *Tank Squadron* (*Gametronics: The Electronic Game Designer's Conference* [Great Neck, NY: Electronic Engineering Times, 1977], 20).

Five years later, Chandler recalled excitement during his job interview, since he agreed with Mattel's vision for what "a home video game ought to be," one where "games provide a lasting entertainment as opposed to a short lived experience."[9] Mattel had not been involved in the arcade market, where gameplay was brief. However, the company intimately understood the domestic sphere as a place for family, leisure, and play—a sphere which could enable "a whole new class of video game," as Chandler concluded.[10] Mattel's home console would support this new class of game with complex, strategic play, "rich graphics," and "long lasting game play values."[11] Sports like baseball and football fit this new paradigm, and Chandler even explained Mattel's vision for videogames using Intellivision's *Major League*

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Baseball—"a real baseball game" with nine innings, a "full-blown field," and "complex animated players."[12]

In early 1977, Mattel's videogame vision was still just a field of dreams needing to be built. Mattel leadership and engineers centered their console development efforts on the Master Component, "the heart of Intellivision" as it was often called in brochures. Without it, no cartridge or extension could function. Most consumers encountered the Master Component on its own and called it Intellivision. In this chapter, we discuss how Intellivision came to be, how key chips and hardware allowed the Master Component to support the home videogames Mattel wanted to produce, and how sports videogames and early game design leveraged these technical features to emphasize the sophisticated strategy and simulated realism that came to define Intellivision's impact on videogame history.

"Intellivision" Emerges

Intellivision was far more complex than any previous Mattel Electronics product. APh, the technology consulting firm in Pasadena, played a vital role helping to develop handheld games and was pivotal to Intellivision as well, but Mattel Electronics needed an additional partner to supply and manufacture a chipset for the Master Component. Before Chandler's arrival, Chang's Preliminary Design group had met with National Semiconductor about a graphical display chipset based on Intel's popular 8080 processor.[13] Chandler continued these conversations, but at the June 1977 CES, he saw two more chipsets. One, from MOS Technology, had an "elegant background" but "no moving objects."[14] This would make it difficult to field a sports team of players and provide sophisticated gameplay. The other, from General Instrument (GI), had "no graphics RAM" included in its cost.[15] Mattel initially decided to work with National Semiconductor, but National Semiconductor tried to postpone the project.[16] This led Mattel to turn to GI.

GI was a large technology company based in New York, founded in 1923. The company produced technology for other firms, with little experience in consumer markets. By the 1970s, the company had several divisions including GI Microelectronics, which eventually developed Intellivision's chipset, and Jerrold, which developed PlayCable (chapter 11). GI had been involved in the videogame market for several years, developing first-generation chips for dedicated television games. Microprocessors were emerging as consumer-grade products, but development costs were high. Stephen Maine, a GI engineer who played a pivotal role designing Intellivision's chipset, noted that "you needed a high volume to amortize the cost. Everybody was looking for a

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market outside of the military that you could pump silicon into, and the only market that would be readily available was a consumer product." Dedicated television games were attractive because televisions were inside millions of homes—the perfect base for a new chip market.

The collaboration between Mattel and GI made sense.[17] GI advertised in their 1977 catalog that their company "does not produce end products. Our slogan, 'We Help You Compete' means just that. We do not compete with our customers. Hence, customers can share their ideas for product innovation."[18] GI had a chipset that could deliver sophisticated videogames and was open to collaboration. Mattel had the capital and marketing expertise to transform GI's chipset into a console, at volumes that would justify the chipset's expense. Lew Solomon, Senior Vice President of GI Microelectronics, explained that GI gave Mattel proprietary rights and shifted about 80 percent of their production to this chipset, "a very risky undertaking if your client can't buy them from you."

Tom Mariner, a contractor at GI, suggested that an inadvertent demonstration played a role in Mattel's decision to move ahead with GI's chipset. Using specs for the proposed system, James drew patterns for an eight-frame "running man" animation—a human figure with arms, legs, and head in fluid running motion. Often shown in commercials, the running man became iconic for Intellivision, used in early sports videogames like *Major League Baseball*, *NFL Football*, and *NASL Soccer*, and later titles like *Tron Deadly Discs* and *Night Stalker*. Even the Mattel Electronics logo featured a generic version of the running man animation (likely from *NASL Soccer*) above "Mattel Electronics," and the *NFL Football* version below (figure 2.2).

The running man graphics highlighted the importance of sports and athleticism from the beginning. James recalled, "The mother of invention was, 'we want to do a football game that calls for football players. We just can't have silhouettes. Can we figure out some way to animate them?'" Mattel sent an engineer to New York in the autumn of 1977 with James's pixel drawings to test how the graphics would work with GI's hardware. Using GI's prototype, Mariner stored James's pixel patterns, put them up in front of a green background, and made the human figures crisscross the screen. Eventually about twenty engineers were "gathered around the prototype," Mariner said, "and they were going, 'Wow, that's cool.'" The visiting engineer called back to Mattel:

> The guy gets on his phone with his boss and he says, "Wow, I'm looking at the running man and it looks good." And you could see him pull the phone away from his ear as though somebody's yelling at him

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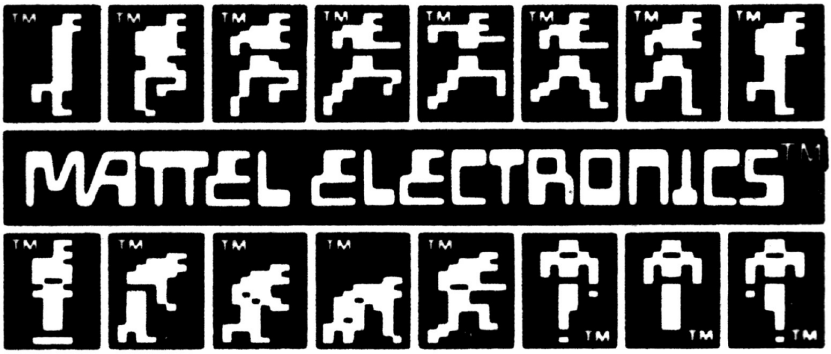

2.2 "Running man" logo.

> wanting to break his eardrum, and he looks at me and says "turn off the computer. They didn't expect you to be able to do this for a month. Therefore they didn't tell me it's a big frickin' secret."[19]

At this point in time, the handhelds were not yet a hit and the Optigan organ fiasco had occurred only five years earlier (chapter 1). It is understandable that some Mattel executives were apprehensive. (Indeed, after National Semiconductor backed out, Ray Wagner, President of Mattel Toys, halted "all Mattel work on video games" for several months.[20]) Ed Krakauer, head of Mattel Electronics at the time, emphasized that Art Spear, Chairman of Mattel, "appreciated the handheld games, but this was a totally different arena for him. And I don't think he was really very comfortable with it." Krakauer added, "When we went into Intellivision there was no support from the top management at all. They told us we were totally on our own and go ahead and try it if we wanted to. It was a little disheartening." Eventually, Spear and Wagner were sufficiently persuaded to support the project. In large part, this was due to the lobbying efforts of Jeff Rochlis, who was hired in 1976 as Director of New Business Development and eventually became the first President of Mattel Electronics.

Mattel, GI, and Magnavox (Intellivision's initial manufacturer) met on November 9, 1977 and agreed to move forward, assigning responsibilities, purchase orders, and production schedules soon after.[21] Since Mattel's engineers could not develop the system entirely in-house, including tasks like circuit testing and software development, Chang enlisted the help of APh, the consulting firm that had helped develop the handheld games. APh programmer David Rolfe was given the task of coding a demonstration of the system, using James's running man graphics, for a private showing in a

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hotel suite at the January 1978 CES in Las Vegas. Rolfe noted that it "simply gave you the ability to run a man around on the screen under control of the handset."

Mattel initially wanted to release the console for Christmas 1978. At the June 1978 CES, Chandler and other staff demonstrated a prototype of their "Electronic Cartridge Video System" to major retailers in a closed suite at the Ritz-Carlton Hotel.[22] But a few days later, it was announced that GI had "advised Mattel, new to video game field, to 'take a longer learning curve' before marketing game."[23]

Given delays, in fall 1978 the Mattel design team considered switching to work with Texas Instruments (TI). TI had a new, powerful graphics chip, the TMS9918 (later used in ColecoVision) and was collaborating with the toy company Milton Bradley (which was developing a low-cost home computer).[24] "Joining forces was strongly considered," Chandler reflected a few years later.[25] Moreover, TI's plans for the TI-99/4 signaled their expertise in home computing, which dovetailed with Mattel Electronics' desire to expand Intellivision into a home computer. However, while switching to TI's technology would potentially allow "roughly equivalent" games, Mattel Electronics leadership worried that it would require reprogramming games, less controller sophistication than they desired, and losing the ability to support the personal computer applications that Mattel envisioned (chapter 3).[26] In terms of gameplay, for example, the TMS9918 could support thirty-two single-colored moving objects, but only four moving objects on the same horizontal line. An individual from APh recalled that one "reason we didn't change over was because [TI] could not put five items on a line. Look at baseball. There's two base runners, the pitcher, the ball, the player that's going to catch the ball. There could be five objects on a line. You couldn't get around it." In contrast, GI's graphics chip supported eight moving objects and could display them on a single line, crucial for more realistic representations of sports like baseball and football.

During the fall of 1978, around the time Mattel Electronics was considering a collaboration with TI, the name "Intellivision" was conceived.[27] Krakauer recalled a discussion where the idea emerged "to suggest 'intelligent television': the player's actions/reactions would directly impact the result appearing on the TV screen."[28] The idea was likely influenced by conversations with GI engineers. Maine remembered realizing that televisions would become increasingly smarter as they were influenced by more powerful, programmable microprocessors, and "so we came up with this idea that there had to be a train of software architecture and hardware architecture and it's going to eventually become 'intelligent vision.'" Maine emphasized that GI was not in the "branding business" like Mattel, so it did not matter

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to them that "Intellivision" riffed off the idea of intelligent vision. But while GI was fine with Mattel's name for the console, it might matter to another technology company—Intel. Krakauer flew to Northern California to meet with Gordon Moore and Robert Noyce, two of Intel's founders, recalling how "they were gracious and gave permission" so long as the words "Intelligent Television" appeared in font at least 50 percent the size of the word "Intellivision."[29] At the January 1979 CES, along with twenty-four cartridges and a projected retail price of $250, "Intellivision: Intelligent Television" was publicly revealed for the first time.[30]

The STIC, Keystone of the Intellivision's Design

Chandler's original specifications for Intellivision explained that the "systems engineering task is to develop a programmable video game which is attractive, versatile, offers sophisticated game play and captivating visual and sound effects."[31] GI's chipset made this achievable. The Master Component's hardware architecture is divided into two halves (figure 2.3). One half is composed of gameplay processing elements: the central processing unit (CPU), scratchpad memory, EXEC operating system, and cartridge game code. The other half is composed of graphics display elements: the Standard Television Interface Chip (STIC), graphics random access memory (GRAM), and graphics read-only memory (GROM).[32] These two halves, which we might describe as the "videogame logic system" and "graphics system," share access to the 16-bit System RAM, the RA-3-9600, which lets them communicate but also separates them into distinct spheres that are isolated from each other at crucial moments.

All of these chips are indispensable, but the STIC is perhaps the most important—the "keystone of the Intellivision design," as Intellivision's primary programming manual calls it.[33] The STIC is Intellivision's graphics controller, and it defines, processes, and automatically displays graphics on a cathode-ray tube (CRT) television. At GI the STIC was designated the AY-3-8900, and early Mattel documents referred to the Master Component as the "8900 System."[34]

The STIC was designed at GI in the mid-1970s by Stephen Maine, working closely with other GI engineers including Eric Berman and Duncan Harrower. Harrower, who would conceive the system architecture for Intellivision, began designing a first-generation game chip for televisions in 1974.[35] Harrower's AY-3-8500 had six *Pong*-like games built in, including tennis, soccer, squash, and rifle shooting. It was ingenious. Many companies wanted to enter the television games business but did not have the expertise to develop complicated circuits. In December 1975, GI began

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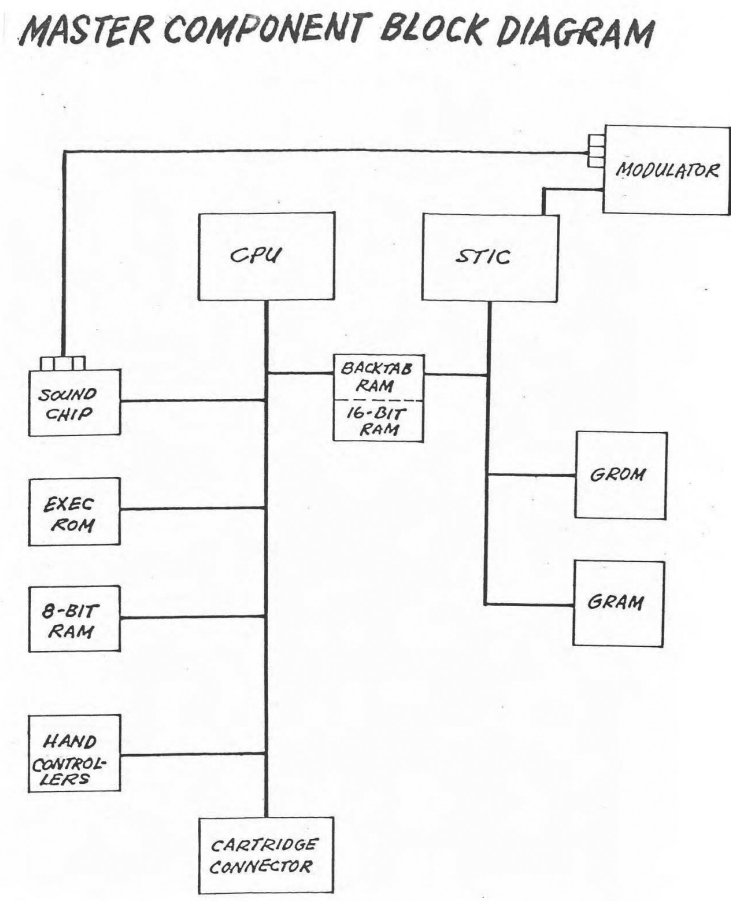

2.3 David Chandler, "Master Component Block Diagram" (Paul Chandler archive).

selling the AY-3-8500 to companies including Coleco, Radio Shack, and Magnavox.[36] This strategy made the AY-3-8500 massively successful. In 1976 "over 5 million such parts were shipped" and "hundreds of different game systems used it worldwide."[37]

Yet, GI engineers wanted to move beyond first-generation videogames and develop a chip that could be used for multiple games. Maine explained that "dedicated television game chips consumed huge resources to develop, and we needed to develop a platform that could easily be adopted around a specific game concept."[38] This evolved into the idea of a programmable videogame system where a graphics chip handled standardizing and displaying the television image while a CPU managed the game logic supplied by a cartridge. Maine emphasized, "The idea was to try to find a solution

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that would enable us to produce more product in a shorter period of time. So the original concept was something called the STIC, Standard Television Interface Chip."[39]

While some programmers playfully called the STIC the "Silly Television Interface Chip," it was a crucial, powerful device.[40] As its name implies, the STIC interfaces with CRT televisions to automatically display the image. Within CRTs, a beam fires electrons onto a plate of glass coated with phosphors that glow when hit. Modulating the electrons causes the phosphors to display different colors and intensities. The electron beam sweeps across the coated glass in horizontal scanlines, moving left to right and top to bottom. When the beam arrives at the end of a single scanline, it returns to the left edge of the screen to begin another line, a process called horizontal retrace or horizontal blank. When the beam finishes painting the frame at the bottom of the screen, it returns to the top-left corner to begin another frame, a process called vertical retrace or vertical blank. It does this sixty times a second.[41] The STIC was engineered to synchronize with the beam, continuously outputting information that the CRT uses to modulate the beam and change the image as it is drawn (chapter 5).

Perhaps most important, the STIC defines Intellivision's advanced graphics capabilities and overall visual aesthetic.[42] For example, the STIC defines the visible playfield of games—a tiled background of 240 graphics cards, 8×8 pixels in size and arranged in a 20×12 grid. Since each card is eight pixels wide, Intellivision's resolution is in theory 160×96 (in chapter 7, we discuss why it is actually 159×96). The STIC also defines Intellivision's eight moving objects, the bread and butter of interactive videogaming. Berman explained that the basic concept for Intellivision was, "We'd have different planes of video. One we called the background, which was just a grid of panels." The problem was "you couldn't interact with that," Berman said, so "we decided all games needed something that you would drive around, move around, things that move, and we called them moving objects."[43] The race car in *Auto Racing*, the quarterback in *NFL Football*, the laser crosshairs in *Space Battle*, even the square cursor to place schools and factories on the islands of *Utopia*—all are created from Intellivision's moving objects.

Hardware support for moving objects was important for the Intellivision design team, and the technical limitation of eight moving objects shaped many Intellivision games. In fact, once the limit of eight moving objects is understood, you can often count the objects and deduce how programmers worked within the constraint. For example, only eight players take the field at the beginning of *Major League Baseball*: the catcher is already in place as a static background image. Once the players reach their positions, the code transforms them into background images. Only then does the batter run out

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onto the field. In *NFL Football*, ten players appear on the field, but only eight run out at first; the other two suddenly appear at the huddle. During plays, the two centers (or nose guards) remain stationary as static background images. This makes sense because in a real football game the centers are often locked in tight struggle after the hike.

The STIC provides programmers with versatile means to manipulate these objects. Its hardware stores essential display information in its processor registers, which means that it has its own fast, internal storage of key data. These STIC registers, as they are called, contain information including the horizontal and vertical positions of all eight moving objects, data pertaining to how moving objects are displayed, an interaction table to record overlaps between moving objects (and other parts of the screen), and information regarding background display modes, background color, and borders.[44] In terms of moving objects, the STIC can change their location, detect collisions between them, and manipulate their sizes and resolution. For example, to change the position of a moving object, programmers need only update the STIC with the object's horizontal and vertical coordinates. The STIC will adjust the object's position automatically during display time.

The STIC can also do things like flip and mirror an object horizontally or vertically, enlarge or shrink it at different resolutions, or make it invisible so the STIC will not display it. For example, the *Major League Baseball* code contains a routine called "Select Picture Direction" that will change the mirroring of objects, which is important since the fielders or base runners can easily be flipped when a player chooses to change direction. In addition to mirroring, players can also see the horizontal zoom effect in *Shark! Shark!*—a game where players control a fish that eats smaller fish to grow larger while not being devoured by bigger fish. The increasing fish sizes are often created by toggling the STIC's horizontal zoom feature.

The STIC itself does not contain the graphics it displays—like pictures of fish or baseball players—but fetches them from GRAM and GROM when it draws a frame of the displayed image. Sixty times a second, the STIC, GRAM, and GROM are completely isolated from Intellivision's CPU. During this time, the STIC uses the data stored in its internal memory, reads information from the System RAM, and fetches graphics cards stored in GRAM and GROM to assemble the displayed image. Both moving objects and background graphics use cards from GRAM and GROM, with each card containing 8×8 pixel patterns, which are the building blocks of Intellivision's graphics. GROM is read-only memory (data burned onto a ROM chip that cannot be changed), but GRAM is random access memory that can be programmed and altered.

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                    APPENDIX B

              GROM CHARACTER LIBRARY

#96          #97          #98          #99          #100
----------   ----------   ----------   ----------   ----------
|        |   |        |   |XXXXXXXX|   |XXXXXXXX|   |        |
|        |   |        |   |   XXXXX|   |XXXXX   |   |       X|
|        |   |        |   |      XX|   |XX      |   |     XXXX|
|        |   |        |   |        |   |        |   | XXXXXXXX|
|      XX|   |XX      |   |        |   |        |   |XXXXXXXX|
|   XXXXX|   |XXXXX   |   |        |   |        |   |XXXXXXXX|
|XXXXXXXX|   |XXXXXXXX|   |        |   |        |   |XXXXXXXX|
----------   ----------   ----------   ----------   ----------

 #101         #102         #103         #104         #105
----------   ----------   ----------   ----------   ----------
|        |   |XXXXXXXX|   |XXXXXXXX|   |     XXX|   |XXX     |
|        |   |XXXXXXXX|   |XXXXXXXX|   |  XXXXXX|   |XXXXXX  |
|X       |   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|
|XXXX    |   | XXXXXXX|   |XXXXXXX |   |XXXXXXXX|   |XXXXXXXX|
|XXXXXXX |   |    XXXX|   |XXXX    |   |XXXXXXXX|   |XXXXXXXX|
|XXXXXXXX|   |       X|   |X       |   |XXXXXXXX|   |XXXXXXXX|
|XXXXXXXX|   |        |   |        |   |XXXXXXXX|   |XXXXXXXX|
|XXXXXXXX|   |        |   |        |   |XXXXXXXX|   |XXXXXXXX|
----------   ----------   ----------   ----------   ----------

 #106         #107         #108         #109         #110
----------   ----------   ----------   ----------   ----------
|XXXXXXXX|   |XXXXXXXX|   |        |   |        |   |XXXXXXXX|
|XXXXXXXX|   |XXXXXXXX|   |        |   |        |   |  XXXXXX|
|XXXXXXXX|   |XXXXXXXX|   |        |   |        |   |    XXXX|
|XXXXXXXX|   |XXXXXXXX|   |        |   |        |   |      XX|
|XXXXXXXX|   |XXXXXXXX|   |      XX|   |XX      |   |        |
|XXXXXXXX|   |XXXXXXXX|   |    XXXX|   |XXXX    |   |        |
|  XXXXXX|   |XXXXXX  |   |  XXXXXX|   |XXXXXX  |   |        |
|     XXX|   |XXX     |   |XXXXXXXX|   |XXXXXXXX|   |        |
----------   ----------   ----------   ----------   ----------

 #111         #112         #113         #114         #115
----------   ----------   ----------   ----------   ----------
|XXXXXXXX|   |      XX|   |XX      |   |XXXXXXXX|   |XXXXXXXX|
|XXXXXX  |   |    XXXX|   |XXXX    |   |XXXXXXXX|   |XXXXXXXX|
|XXXX    |   |  XXXXXX|   |XXXXXX  |   |XXXXXXXX|   |XXXXXXXX|
|XX      |   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|
|        |   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|   |XXXXXXXX|
|        |   |XXXXXXXX|   |XXXXXXXX|   |  XXXXXX|   |XXXXXX  |
|        |   |XXXXXXXX|   |XXXXXXXX|   |    XXXX|   |XXXX    |
|        |   |XXXXXXXX|   |XXXXXXXX|   |      XX|   |XX      |
----------   ----------   ----------   ----------   ----------
```

2.4 GROM character examples from the Intellivision programming manual "Your Friend, The EXEC" (page B-1).

GROM, the RO-3-9503 chip resident within every Master Component, contains a set of prefixed images such as the system's alphanumeric character set and other geometrical shapes (figure 2.4). These graphics were intended to be reused in multiple videogames, saving space on game cartridges. Theoretically GROM could hold up to 256 images, but Intellivision's EXEC operating system steals some space on the chip for its own use.[45] Thus, GROM contains data for only 213 predefined image cards. Symbols like letters, numbers, and punctuation were key items to put in GROM because every game used them for titles and scores. For example, the letter "E" is stored at GROM location #37 as an 8×8-pixel card, with each row being a byte of data (8 bits) that tells the STIC if pixels are "ON" or "OFF"—generally, should the pixel in the card be displayed as a defined foreground color or not (chapter 4). Thus, the first row of the "E" is stored as "01111110," the second as "01000000," and so on (figure 2.5).[46]

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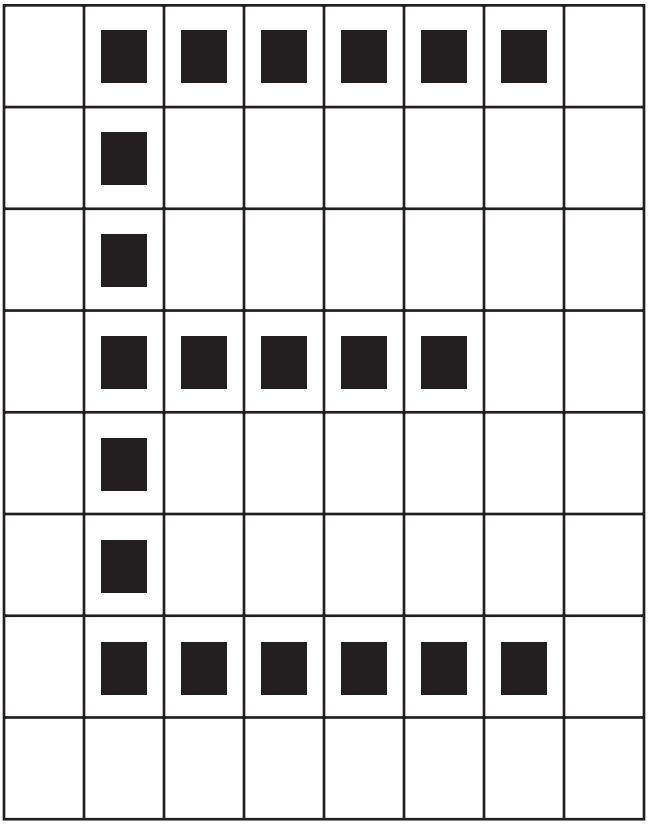

2.5 The letter "E" as stored in Intellivision's GROM chip.

But what about other shapes? Rolfe recalled that some ideas for GROM from Mattel included "playing card images of hearts, spades, clubs, and diamonds," but this would be unnecessary for many videogames—a fact Rolfe recognized even while programming *Las Vegas Poker & Blackjack*.[47] Simple shapes and lines were more broadly useful: for instance, *Advanced Dungeons & Dragons* could use them for its caves and mazes (figure 2.6).

Unlike GROM, GRAM allows for programmer-defined graphics cards, which was essential to Mattel Electronics' plans for sophisticated graphics. Programmer-defined graphics are stored on game cartridges and then loaded into GRAM when the game initializes or when needed. For example, "running man" animations used in titles like *Major League Baseball*, *Night Stalker*, and *Tron Deadly Discs* require multiple graphics cards cycled through eight-frame animation sequences. These cards are loaded from the cartridges into GRAM. Without GRAM the iconic

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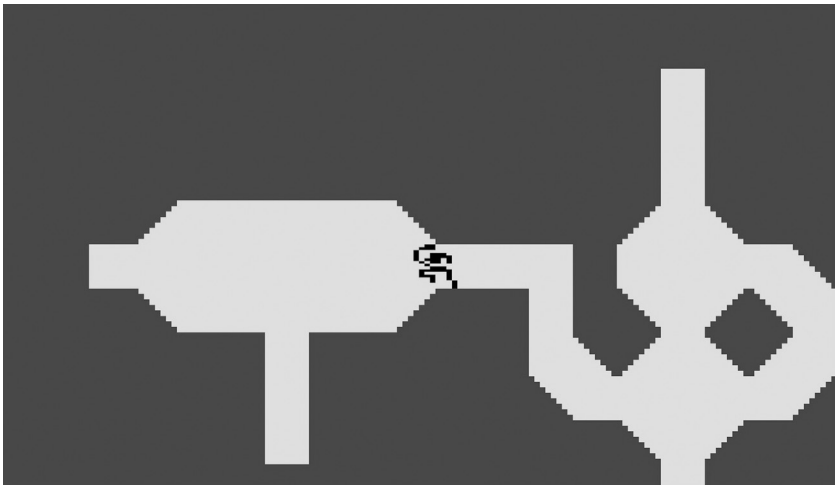

2.6 *Advanced Dungeons & Dragons* cave.

running man would be impossible, since its graphics were not stored in GROM.

The GRAM stored on the Master Component is provided by two 256-byte GTE-3539 chips, for a total of 512 bytes of RAM. Since each graphics card is defined by 8 bytes, one for each line of an 8×8-pixel card, GRAM can hold up to sixty-four cards. This was a key constraint of the platform.[48] This limitation affects the look of the playfield because it is impossible to have more than sixty-four unique programmer-defined cards in a background grid of 240 cards. If programmers use every GRAM card for the background this would constitute only 26.7 percent of the playfield. In practice, the number of available GRAM cards is less than sixty-four because moving objects use significant GRAM space as well. As a result, playfields are constructed by combining cards from GROM and GRAM and reusing them. For example, the islands used in *Utopia* would have required forty-five unique cards for a realistic, never-repeating shoreline. This would have occupied GRAM needed for other background graphics and moving objects; thus, some shoreline cards were repeated. Likewise, in one splash screen for *Thunder Castle*, programmer Connie Goldman reused many cards in the body of the huge green dragon with its tail wrapped around a castle (figure 5.4). The symmetrical castle also has repeated cards, and the image sits over a blank, black void that accounts for many duplicate cards as well. Even the two "E" characters in the custom title font use the same GRAM card.

The *Thunder Castle* splash screen exemplifies another crucial function of the STIC: displaying the background layer of graphics. During active display,

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John P. Sohl
9 June 1981

Screen Format

BACKTAB =

$200 +	$00	$01	$02	$03	$04	$05	$06	$07	$08	$09	$0A	$0B	$0C	$0D	$0E	$0F	$10	$11	$12	$13
512 +	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	$14	$15	$16	$17	$18	$19	$1A	$1B	$1C	$1D	$1E	$1F	$20	$21	$22	$23	$24	$25	$26	$27
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	$28	$29	$2A	$2B	$2C	$2D	$2E	$2F	$30	$31	$32	$33	$34	$35	$36	$37	$38	$39	$3A	$3B
	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
	$3C	$3D	$3E	$3F	$40	$41	$42	$43	$44	$45	$46	$47	$48	$49	$4A	$4B	$4C	$4D	$4E	$4F
	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
	$50	$51	$52	$53	$54	$55	$56	$57	$58	$59	$5A	$5B	$5C	$5D	$5E	$5F	$60	$61	$62	$63
	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
	$64	$65	$66	$67	$68	$69	$6A	$6B	$6C	$6D	$6E	$6F	$70	$71	$72	$73	$74	$75	$76	$77
	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
	$78	$79	$7A	$7B	$7C	$7D	$7E	$7F	$80	$81	$82	$83	$84	$85	$86	$87	$88	$89	$8A	$8B
	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
	$8C	$8D	$8E	$8F	$90	$91	$92	$93	$94	$95	$96	$97	$98	$99	$9A	$9B	$9C	$9D	$9E	$9F
	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
	$A0	$A1	$A2	$A3	$A4	$A5	$A6	$A7	$A8	$A9	$AA	$AB	$AC	$AD	$AE	$AF	$B0	$B1	$B2	$B3
	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
	$B4	$B5	$B6	$B7	$B8	$B9	$BA	$BB	$BC	$BD	$BE	$BF	$C0	$C1	$C2	$C3	$C4	$C5	$C6	$C7
	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
	$C8	$C9	$CA	$CB	$CC	$CD	$CE	$CF	$D0	$D1	$D2	$D3	$D4	$D5	$D6	$D7	$D8	$D9	$DA	$DB
	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
	$DC	$DD	$DE	$DF	$E0	$E1	$E2	$E3	$E4	$E5	$E6	$E7	$E8	$E9	$EA	$EB	$EC	$ED	$EE	$EF
	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239

2.7 Programmer guide to Intellivision's BACKTAB grid (John Sohl, "Screen Format," June 9, 1981, Blue Sky Rangers archive).

the STIC grabs data that identifies the memory addresses of the GROM or GRAM cards used for moving objects from its own internal registers, but it fetches pointers that identify cards for the background grid from Intellivision's System RAM, the bespoke RA-3-9600 chip developed by GI. As a memory device, the System RAM contains 352 16-bit words that store key information. It is the only 16-bit-wide memory within the Master Component, making it crucial to the system architecture. This memory is separated into two parts. First, it offers 112 16-bit words for system use.[49] Second, it contains the BACKTAB (see the center of figure 2.3). This structure stores 240 14-bit words that describe the graphics cards used for Intellivision's 20×12 background grid, including whether they come from GRAM or GROM.

Mattel programmer John Sohl created a printout of the BACKTAB that shows Intellivision's screen format—the background grid of graphics (figure 2.7). This document provides the memory addresses for each BACKTAB entry stored in the System RAM, helping programmers locate and address particular BACKTAB entries in their programs. Each 14-bit BACKTAB entry contains information such as which 8×8-pixel graphics card the STIC needs to fetch from memory, where to fetch it, and crucial color

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information for the card's foreground "ON" pixels and "OFF" background pixels.[50] The BACKTAB is essentially a display list of instructions telling the STIC how to assemble the background. This relieves CPU labor because the STIC uses these instructions to draw the image instead of relying on the CPU for guidance during active display. Moreover, the CPU can change BACKTAB entries when the STIC is not fetching them, allowing programmers to control how the STIC will display the background.

This background grid undergirds all Intellivision games, constructing the system's playfield and shaping its visual and gameplay aesthetics. For example, Mattel programmer Stephen Roney created an unreleased game called "Hypnotic Lights," inspired by Rubik's Cube. The game depicts a tiled screen of multiple colors with the goal of scrolling rows and columns of tiles to match four adjacent colors in a square. Matching colors rewards points, triggering an abstract animation that replaces the matched tiles. "Hypnotic Lights" was canceled, but it anticipated match-three casual games like *Bejeweled* and *Candy Crush*. "Hypnotic Lights" was built on the technical structure of Intellivision's background layer, presenting the structure as is—a grid of individual graphics cards devoid of any pixel patterns.

Once one knows this structure, it can be identified in many Intellivision games. It is a key element in titles like *Loco-Motion*, *Happy Trails*, *Mind Strike, Space Spartans*, and *Tron Solar Sailer,* games that incorporated the grid into various game mechanics. It also eased playfield design for traditional board games like *Checkers*, *Reversi*, and *USCF Chess*, as well as maze games like *Lock 'n' Chase* and *Lady Bug*—where corridors and walls correspond to the background grid's columns and rows. It even eased innovations like Rick Koenig's *Motocross* level design feature which increased the play value and "reusability" of the cartridge, as Koenig put it, by allowing players to use predefined background cards to create their own race tracks.

Ultimately, the STIC's logic circuits are designed to determine display priorities between the background and moving object layers during active display time. Does a moving object overlap a background card at a particular pixel location? Are there multiple moving objects that overlap? If so, which has priority? For each pixel in Intellivision's 159×96 screen resolution, the STIC determines one of Intellivision's sixteen colors to output to Intellivision's color processing chip, the AY-3-8915, and ultimately to the television. Thus, it makes sense to call the STIC the "keystone" of the Intellivision's design. By determining the display priority of pixels, controlling moving objects, and structuring Intellivision's distinctive background grid, all Intellivision games depend on the STIC.

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While the STIC is an essential chip that defines the look and structure of Intellivision games, it needs the CPU. During active display, when the electron beam of the CRT is painting the image on the screen, the STIC works alone and automatically sends signals to the television to change the image. However, during vertical retrace when the display is not active, the STIC and CPU must communicate or the videogame image will not be updated for the next frame.

The second half of the Master Component's hardware architecture is the videogame logic system, centered on the CPU (figure 2.3). The CPU crunches the game logic—a mélange of code executed from Intellivision's EXEC operating system and a game cartridge (chapter 5). While the STIC is actively drawing the display, the CPU executes game program routines, performing operations and calculations, updating key game variables, and so forth. When active display ends, the CPU is interrupted by a signal from the STIC, letting the CPU know that it can now communicate with the graphics area. In addition to being a memory device that houses the BACKTAB, the System RAM allows the two domains in Intellivision's system architecture—the CPU and STIC domains—to communicate. After the CPU receives the interrupt signal, it has a brief period during vertical retrace when it can change moving object properties by updating STIC registers and even swap graphics cards in GRAM (important for animating moving objects). This is critical, time sensitive work, and the CPU turns to execute the EXEC's interrupt service routines to update the STIC.

The Master Component's CPU was a GI chip called the CP1610. It was a child of the CP1600, a microprocessor originally developed by Jeff Stein and other engineers at Honeywell in 1973 to operate industrial control systems. Stein explained that Honeywell wanted to replace its larger, expensive, analog control systems with smaller, cheaper, digital controllers. Stein's team experimented with emerging microprocessors, like the Intel 8008, the first 8-bit microprocessor introduced in 1972. The 8008 ran too slowly to handle the multiple control loops that Honeywell needed, so they developed their own microprocessor, a faster 16-bit chip that could run sixteen different control loops. Stein explained that the processor had to execute "16-bit multiplies and divides" to perform the complex, real-time calculations required. After prototyping the chip, Honeywell sought a manufacturer and chose GI. Realizing that microprocessors were going to be big business, GI's management hired Stein away from Honeywell in 1974 to run GI's microprocessor memory group. GI continued to work with Honeywell,

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developing what would become known as GI's Central Processor 1600, or simply the CP1600.

The CP1600 was designed according to robust specifications so that it would not fail in crucial infrastructure.[51] Stein emphasized that once such a chip was installed, "you can't just go in and change it because a better widget came out next year." When *Microcomputer Digest* reported on Honeywell's new chip in 1975, they noted, "It may be used for an oil refinery process control system or a freeway traffic control system for some California cities."[52] It may have been used by the military or for nuclear reactors as well.[53]

While the industrial uses of the CP1600 remain mysterious, equally curious was its migration to videogames. The CP1600 was completed in 1975, the same year that GI's AY-3-8500 ball-and-paddle chip was released, eventually storming the first-generation videogame market. When GI began developing a programmable videogame chipset to extend their dedicated videogame chip business, they needed a CPU. Fortunately, they had one. "We chose the CP1600 for no other reason except that we had it," Maine said.[54] GI engineers developed a version of the CP1600 for consumer products, the CP1610. Sometimes chips enter the world of videogames simply by chance.

However, there was a problem: the chip ran too hot. Because Honeywell needed a fast chip to run multiple control loops simultaneously, GI designed the original CP1600 to run up to 5 MHz. Yet, at least while Stein worked there in the 1970s, GI never shipped a CP1600 that ran at this speed. Even slower chips were too hot. Stein explained that GI "got chips to run at 3 MHz but they were literally on fire. You couldn't touch it." When shipping CP1600 chips that ran at 3 MHz to Honeywell, GI included an explanation of how to add heatsinks so they would not malfunction. The chips designed for Honeywell were packaged in ceramic, but for the consumer market GI had to use cheaper plastic packaging, which dispersed heat less efficiently. Since manufacturing millions of consoles which might overheat was out of the question, GI abandoned hopes of running the CP1600 at 5 MHz or even 3 MHz. Instead, they developed the CP1610. This chip runs at 1.79 MHz (its speed is often listed as half this, 894.886 kHz [kilohertz, not megahertz] because the CPU divides its clock speed into two periods).[55] Even at this lower speed, GI and Mattel epoxied heatsinks over the chip. If you open up an original Master Component, you will likely see three chips covered in heatsinks—the CP1610, the STIC, and the RA-3-9600—the core chips in the system architecture.

Both Maine and Stein emphasized that the CP1610 differed from the CP1600 only in its slower speed and plastic casing.[56] Intellivision expert Joe Zbiciak explained that "when the Intellivision came out it actually had a

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slower processor than its contemporaries." Another expert, "decle," noted that 1.79 MHz was not slower than other chips—the issue was that the CPU's internal design required more clock cycles per instruction than its competitors. Instructions took longer to perform on the CP1610. Yet the CP1610's slower speed would shape the system and its videogames. For example, Rolfe programmed the EXEC operating system conservatively because, he said, "I was concerned that I might run out of CPU time." When the CP1610 updates the STIC and GRAM during vertical retrace it must do so quickly, but the CPU's slower speed contributed to Rolfe's design of the EXEC to update this information over multiple frames, during multiple interrupts. For example, instead of updating moving object information contained in the STIC sixty times a second, the CPU updates most of this information over a three-frame period, thus twenty times a second. This led to slower videogames when using the EXEC.

Indeed, the CPU could act as a bottleneck, creating challenges for Mattel and APh programmers. Rick Levine, one of *PBA Bowling*'s programmers and an avid bowler himself, said the game "was based on physics, but it was faux physics." Levine referred to faux physics because Intellivision's CPU was not fast enough to crunch complex calculations simulating lane slickness or a ball hitting a pin. APh programmer Tom Loughry recalled similar issues, eventually reworking a first-person periscope view in *Sub Hunt* because Intellivision "simply did not have the CPU power to do what we wanted to do." The game code was tracking various objects in three-dimensional space relative to the player's submarine, but Loughry "had to completely redesign *Sub Hunt* because we simply couldn't track that many objects in three dimensions." The CPU was not able to handle the required calculations given other processing it had to do.

Scrolling the screen also caused difficulties. The STIC actually has two "delay registers" used to offset the horizontal and vertical location of the background playfield up to 7 pixels. Thus, if one sets the horizontal offset to 7, the visible playfield will suddenly jump 7 pixels to the right when the next frame is drawn. For a smoother transition, programs can increase the offset gradually. In *World Championship Baseball*, for example, if the ball approaches the screen border in the outfield, the screen will scroll up slightly as the ball stops.[57] However, the delay registers were primarily intended to facilitate more complex forms of scrolling—like when football players run down the field and hidden parts of the field become visible. In addition to the delay registers, the STIC contains two border extension registers that extend the top border down one row of cards and the left border over one column of cards. This effectively makes the background grid 11×19 cards, since the first row and column of cards are hidden to facilitate scrolling and mask

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potential glitches that occur on the edges. Coupled with the delay registers, the border extensions could facilitate smooth scrolling screens.

Yet scrolling requires intense computational labor, pushing the CPU to its limits. Programmers must change background cards as some disappear off screen and new ones appear, while also updating moving objects quickly so the STIC has the correct information to display the screen without error. For example, a scrolling module developed at APh was used in *Space Hawk* and contains a routine called "Fix Up Everything that Scrolled." A comment in the code reads, "This routine goes through and updates all the hardware and software databases to reflect the screen moving as a result of scrolling. It has no more than 2460 [CPU] cycles to get done. It takes 2435 as is."[58] This provides a precise count of CPU cycles that programmers have to update essential game data before the next frame is drawn. Otherwise, the STIC will draw the screen incorrectly. In the middle of the scrolling code the programmer comments "Pant . . . Pant," revealing the intense sprint underway to finish the updates. In *Space Hawk*, the screen can scroll both horizontally and vertically as the player moves in 2D space, but there simply was not enough time during one vertical retrace to do both.[59] While playing *Space Hawk*, if you send the spaceman in a diagonal direction at high speeds, objects start moving in jerky step-patterns, revealing how horizontal and vertical positions are updated separately during different vertical retrace periods.

Sports, the Master Game

The first videogame programmed for the Master Component was a sports title, *Major League Baseball*. Rolfe programmed *Major League Baseball* while coding the Intellivision's EXEC operating system, described further in chapter 5. This allowed Rolfe to understand how the system architecture worked, how to leverage the CPU's and the STIC's capabilities, and how to facilitate communication between them. It helped Rolfe understand what the EXEC should do and what features it should include. The baseball diamond could be depicted as a simple, non-scrolling field, allowing Rolfe to understand how to load and display a game's background with graphics cards from GROM and GRAM. A team of defensive players running out onto the field provided a case study for how to implement, control, and update the STIC's eight moving objects. Moving the "running man" from base to base required controller input, animations, and object movement, behaviors the EXEC could implement. Even baseball's relatively languid tempo influenced the operating system: the slower pace of videogames that resulted from Rolfe's design of the EXEC was not an issue for *Major League*

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Baseball. Rolfe even included code in the EXEC for "Crowd Sounds"—heard in many Intellivision sports titles, including *Major League Baseball*.

Indeed, sports were central to the elaboration of the Master Component's capabilities and also Intellivision's history. Creating an electronic football game galvanized Mattel's initial interest in videogames. The original handhelds were sports themed, and *Football* became a megahit. Eleven out of Intellivision's first twenty cartridges were sports. This focus set Intellivision apart from its competitors, an intentional facet of Mattel Electronics' business strategy to battle Atari. Krakauer noted that "Atari had left a hole in the whole sports genre, and that was really our point of entry." By 1982, sports and Intellivision had become synonymous, with one observer noting that Mattel Electronics is "recognized primarily for their superior sports cartridges. And they know it."[60]

Scholars have noted two primary origin stories for videogames: space and sports.[61] The well-known space-centric history begins with 1962's *Spacewar!*, runs through *Space Invaders*, and leads to Atari. In contrast, "little ink has been spilled on the topic of sports videogames," which "still sit on the sidelines, so to speak."[62] A sports-centric video game history might begin with early computer games like *Pool Game Simulation* (1954) and William Higginbotham's *Computer Tennis* (1958), running through Atari's *Pong* as a simulation of table tennis, numerous sports-related *Pong* clones, and eventually to Intellivision's realistically simulated sports titles.[63] In the early 1980s, game designer Chris Crawford suggested that "[l]acking original ideas, designers turned to sports for models."[64] No doubt, designers in the early US videogame industry drew on an established history of simulating sports, and marketers could promote videogames through a familiar cultural activity. However, it is crucial to acknowledge the centrality of innovative sports games, and Intellivision, to videogame history.[65]

Before Intellivision, Mattel was familiar with sport as play. The successful Hot Wheels brand, for example, was explicitly linked to auto racing. Mattel had already created Talking Football and Talking Baseball in the early 1970s, and even licensed professional sports for their Instant Replay toy. Moreover, Mitch Junkins (Manager of Business Development for Mattel Toys) helped start an Athletic Group in 1977 that made innovative products including skateboards and roller skates, looking to capitalize on active lifestyles. Junkins emphasized, "This was happening at the same time Mattel Electronics was taking off," recalling that his office "sat over the wall" from Rochlis. Indeed, sports themes became fundamentally associated with Mattel's wildly successful handheld games, which Rochlis managed.

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Intellivision took Mattel's history with sports to a higher level. One 1977 industry analysis observed that most "electronic games to date have been electronic versions of popular sports," predicting consumers would "become more sophisticated in their use of games."[66] Yet, instead of abandoning sports for more innovative genres, Mattel Electronics made sports videogames themselves more sophisticated, framing play in terms of realism and intelligence, not only sweat and struggle. In physical sports we find athletic mastery—strength and coordination, the ability to hit a ball or tackle an opponent. However, we also find strategic play, like choosing when to steal a base in baseball or what play to execute in football. Intellivision sports titles combined the excitement of action with the strategic pleasures of an intelligent spectator—one who not only cheers a home run or touchdown but who appreciates tactics and strategic decisions. After all, home videogame consoles during this period usurped living room televisions, often used to watch live sporting events.

Playing sports on Intellivision did not just entail learning to swing a bat or throw a ball. It often entailed managing a team or planning strategy—a point which fit into Mattel Electronics' desire to market Intellivision as sophisticated and intelligent. The *NFL Football* manual emphasized, "Football isn't just a game of knocking heads! Strategy, finesse, and good timing are essential to winning." In Intellivision sports titles, players often occupy roles closer to coaches than athletes. For example, *NFL Football* included a separate playbook to show the player how to select between nine offensive formations and two receivers for a passing play. Ultimately, passing requires five inputs before the action begins—a complicated planning process. Later Intellivision sports games like *World Series Major League Baseball* and *Slam Dunk: Super Pro Basketball* allowed players to use statistics to build teams, in some cases working within a budget and differing player salaries. Strategy was even emphasized in sports normally understood in terms of physical prowess. In *Boxing*, the player-as-coach chooses from six boxers with different strengths like "strong defense," "offensive power," or "exceptional endurance." The manual emphasizes, "Boxing is skill, not just throwing punches. If you want to win consistently, be ring wise! . . . Think and then fight . . . Use strategy, think ahead."

Intellivision sports games were also an early means to articulate realism, which became crucial to Intellivision's marketing and aesthetics (chapter 4). Realism for Intellivision was a way to express intelligence. One form of such realism was gameplay realism—fidelity to the physical analogue. Observers noted how "Intellivision shepherded in a new era of TV games. Not only would realism be stressed graphically, but rules, especially in sports, could be adhered to."[67] *Major League Baseball* included not just

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hits and strikes but stealing, bunting, double plays, balls, walks, and forced outs. Mattel Electronics' emphasis on obtaining licenses from official professional leagues (NFL, NBA, and others) reinforced this connection to gameplay realism with a form of licensed realism that buttressed authenticity. The videogame had to appear close to the real thing, a point often highlighted in manuals, like *NFL Football*: "Every aspect of NFL competition has been electronically recreated to put you in the pressure cooker of big time football."

Even realistic time spans were significant to Intellivision sports. A 1978 industry news report noted that many sports cartridges for Mattel's upcoming console would feature "single, hour-long games" appropriate to domestic space.[68] As mentioned previously, Chandler emphasized that "the idea of what a home videogame ought to be" for Intellivision would be "like a baseball game that can last for a while."[69] Some sports videogames had no time limit, like *Major League Baseball* with its nine innings. Yet, many were based on games with fixed periods: *NASL Soccer* has two forty-five-minute halves; *NHL Hockey* has three twenty-minute periods; *NFL Football* has four fifteen-minute quarters. To preserve realism, all three employ what their manuals term "simulated time." For instance, the code for *NFL Football* uses an EXEC process to call a cartridge routine DOCLOCK every three-fourths of a second at the default videogame speed. DOCLOCK checks to see if time has been stopped (for out-of-bounds, time-outs, and other reasons), and if not, decrements the videogame clock one second until the end of the quarter. Time thus flows 25 percent faster in *NFL Football*: sixty minutes of videogame time equals forty-five minutes of physical time.

Intellivision sports titles reinforced the aesthetic of realism in different ways. Some sports games, like *PBA Bowling*, sought a simulated physical realism, allowing players to select "lane slickness" and "ball weight" that impact elements like "deflection" and "pin action"—all terms used in the instruction manual and discussed by professionals. Physical realism was linked to graphical realism, exemplified by the athletic "running man" animation. It was common for programmers and graphic designers to base their animations on real-world analogs. For *Chip Shot: Super Pro Golf*, Steve Ettinger and Connie Goldman developed a "swinging man" based on photographs of professional golfer Jack Nicklaus's swing. Graphical realism could include ambient realism, invoking aspects of sports beyond the actual game—like "authentic bouncing-ball sounds" and "a crowd whose cheers and faces follow the action," as one brochure spoke of *Tennis*. Indeed, *Tennis* and *NBA Basketball* had courts complete with regulation boundary lines, though these decorative details did not impact gameplay. APh founder Glenn Hightower

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and Loughry even proposed "selling advertising on the grandstands" for the never-released "Basketball II," replicating the realistic experience of seeing ads in the stadium. In fact, the Product Manager Susan Bowles met with representatives of Pepsi Cola to explore the idea.[70]

Because Intellivision sports games were often based on experiences of home spectatorship, televisual realism was important. For some titles like *NFL Football* and *NASL Soccer*, the play field was too wide for a television screen. Horizontal scrolling was necessary, and manuals emphasized that "just like a real televised game you see only a portion of the field at any one time." Some manuals even included a graphic with a superimposed TV frame over a portion of a larger sportsfield to illustrate this principle. Instead of making players feel like they were in an arcade, Intellivision sports made players feel like they were watching televised sports at home—but in an interactive, intelligent way.

The televisual design of Intellivision sports videogames extended from initial offerings like *Major League Baseball* and *NFL Football* to one of the final games programmed before the 1983 crash of the US videogame industry, *World Series Major League Baseball*. Under the supervision of Don Daglow, Eddie Dombrower drew even further on television's visual aesthetics. The player has a centerfield camera view from behind the pitcher and a split screen so that players outside the centerfield camera are visible (figure 2.8). Dombrower recalled how:

> At Mattel it was about making it look like television, and that is the television shot, right? The centerfield is always over the right shoulder of the pitcher. The other thing I brought from the TV was the interstitials between the half innings. I blacked out the screen, I brought up who was the next batter, who was coming up. TV isn't only about the visuals. It's about the rhythm of the visuals. That was Don's original directive to me, to make it feel like television.

Dombrower sought to invoke the televisual realism of watching a baseball game from one's living room. The game's catalog description exclaimed, "It's just like playing baseball in front of national TV! The TV cameras catch different angles of the game." As Daglow put it, "We started imitating TV coverage." This was challenging, he added, "because TV is a passive medium. It's not meant to be played. So, when you change perspective on somebody who's trying to control a player—that's pretty brutal. And yet we figured it out." While Cinemaware's 1988 Amiga game *TV Sports: Football* might have been "the first football simulation to mimic the sport's television presentation," *World Series Major League Baseball*, five years prior, sketched

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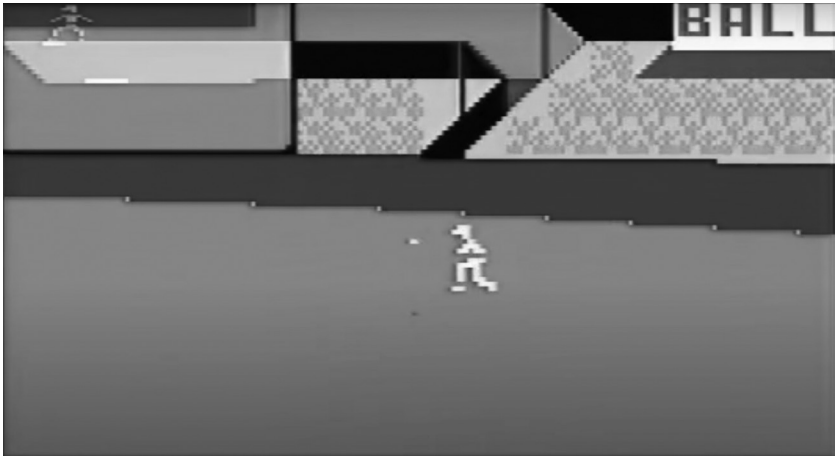

2.8 *World Series Major League Baseball* gameplay showing split screen. Inset box at top left corner shows infield and bases; main screen depicts outfield and stands.

a prophetic vision for future sports videogames and their "aspirations for a 'realistic' televisual presentation."[71]

Supported by the versatile STIC chip and its graphics capabilities, Intellivision's sports titles were a leap beyond *Pong*-type games. The embrace of multiple forms of realism became pivotal to Intellivision sports, supporting the idea that "Intellivision's appeal was the version closer than rival products to the game as played professionally."[72] Intellivision laid a foundation for future sports videogames and their "relentless pursuit of 'authentic' simulations."[73] However, Intellivision's embrace of realism was not universally acclaimed. As one observer noted, sports realism was "the machines's trademark; it is also, in another sense, its inexcusable flaw. At times, Intellivision is just too difficult to play."[74] Its sports titles were not meant to be simple-to-learn arcade games but sophisticated games for the home that often required reading the manual to learn their intricacies. In needing instruction manuals, Intellivision sports titles share features with traditional board games; in requiring consistent practice, they share features with physical sports. As a result, an overabundance of realism could be dull for players seeking a more immediate fix. "Mattel is the victim of realism," said one hardware designer at Mattel: "Its games are slow because people try to make them like the real world, and it takes time to move from one end of a football field to the other."[75] Computationally speaking, a quarterback in *NFL Football* could throw a ninety-yard pass or even turn invisible. However, such violations would undermine fidelity to the physical analogue.

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In 1984, Crawford claimed that sports videogames "take liberties with their subject matter for the sake of playability. The most enjoyable aspects of these computer games have little to do with the real athletic game."[76] This assessment misses that realism can be enjoyable, and for Intellivision, playability was often framed in terms of an interactive, intelligent spectator. However, some titles departed from realism more than others. For instance, scrolling in *NASL Soccer* results in a mechanic where a player disappearing on one edge of the screen reappears on the other. The offsides rule in physical soccer is ignored, and reappearing on the other side of the screen becomes a play strategy. In *Major League Baseball*, stealing bases can become a frolicking (or frustrating) affair where one player can run between the bases again and again, enticing the other player to chase them around or commit a throwing error. The manual even encourages this playful strategy unique to the videogame: "If the defense is asleep or makes an error, don't be afraid to take the next base!" The debate over realism versus playability remained a key point of contention among game designers long after the second generation, with some arguing that "most players only want more realism if it means they get to do more interesting and fun things, not if it makes their game experience more frustrating."[77]

Intellivision sports titles articulated an early version of this debate, demonstrating their historical import. Yet beyond this debate, sports videogames were crucial in shaping the Master Component, and Intellivision's identity more broadly. They articulated Intellivision's connection to realism, to the idea of what intelligent television could be through their reconfiguration of the intelligent spectator, and to forms of sophisticated play within the home that interweaved strategy with action.

Intelligence in the Palm of Your Hand

Intellivision's unique hand controllers were fundamental to the experience of the Master Component as intelligent. Human intelligence is based in "the faculty of manufacturing artificial tools," and the root of manufacturing comes from the Latin word "manus," meaning hand.[78] Intellivision's hand controllers reflect this centrality of the hand to the intelligent human. Indeed, the controllers were crucial to the complex, strategic play that accompanied many of Intellivision's sports titles. For example, an early brochure noted that the controller's "input keys call the play," reflecting how the gamer was a coach selecting a strategy. As some observers noted at the time, "Sports and strategy games are well served by the Intellivision controller, which combines a keypad with directional controls and action buttons, as opposed to Atari's one-button joystick."[79] Whereas Atari's joystick evoked

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piloting and military imagery, Intellivision's controllers evoked the increasingly common "remote controls" for home televisions.[80] The rectangular controllers also followed the design of touch-tone phones that had begun to replace rotary telephones, down to the curling wire connecting them to the Master Component and a twelve-button keypad including the numbers 0 through 9 (figure 0.1). Below, a thumb-controlled disc registered movement in sixteen directions (compared to Atari's eight), with two action buttons on each side.[81]

The hand controller was designed by Chandler with the idea that Intellivision would be more than a videogame system: the controller explicitly offers complex input possibilities for applications beyond games. Indeed, Chandler had extensive knowledge of button interfaces and electrical contacts given his work modifying an analog typewriter to create a digital word processor (chapter 3). Alan Chandler recalled his father wanting to include a keypad "because it was already something familiar to people. Touch-tone phones were coming out," and this would allow users to "get comfortable with it very quickly." The twelve-button keypad uses a soft bubble interface, increasingly common in consumer electronics.[82] Alan noted that his father thought players would want "the sensation of feeling like they could press a button" without bulky keys.

Harrower saw Chandler's controller as "a brilliant piece of design."[83] The controllers managed complexity with an "overlay" system. The keypad is surrounded by a frame, the top of which has an opening for inserting plastic overlays that cover the keypad and customize it for particular games. By the 1930s, the word "overlay" was used for "a transparent sheet placed over a map or diagram . . . to carry instructions or additional material."[84] The overlays contributed to Intellivision's aesthetic of intelligence, serving a pedagogical function by making the keypad less intimidating while facilitating sophisticated gameplay.[85] *Sea Battle* shows how overlays allowed for a complex interface (figure 2.9), in this case identifying ships that players can deploy. Players press the "create" key, followed by selecting one to three ships, then press "deploy" which will create a convoy. The overlay covers the controller's keypad numbers, showing instead the number of a particular ship available to players. Moreover, the "clear" key has been reassigned to create a ship—emphasizing the malleability of design choices provided by the overlay system. For arcade-style videogames with fewer player commands, overlays served more decorative purposes. For instance, the overlays for *Space Armada*—a quasi-clone of *Space Invaders*—obscure eight of the twelve keys on the keypad altogether (figure 2.9).

The complexity of the controller, with its many input possibilities and overlay system, reflected Chandler and Mattel's vision that videogames

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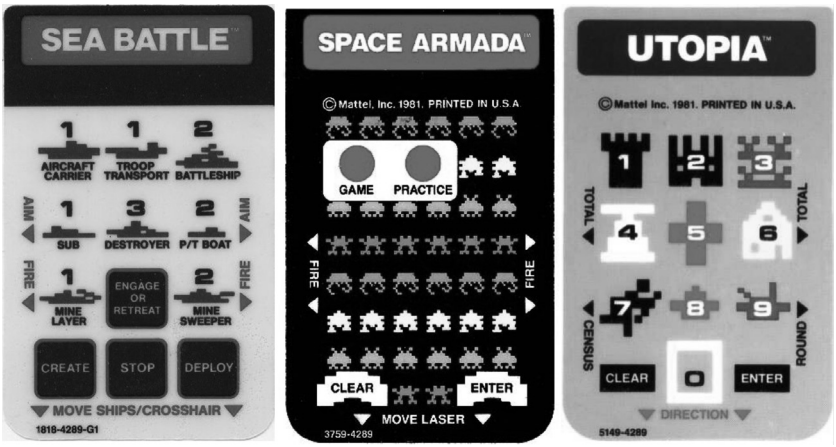

2.9 Overlays for *Sea Battle*, *Space Armada*, and *Utopia*.

would be sophisticated and lasting—appropriate for domestic play. Moreover, the keypad could potentially be used for educational cartridges and non-game applications, which dovetailed with Rochlis's and Chandler's vision that Intellivision would be more than a videogame system. In terms of videogames, the different controller inputs including a keypad and a directional wheel with action buttons created a duality of play. On the one hand, some games would use the side buttons and the disc for directional movement, which would reflect an action, arcade perspective. On the other hand, the keypad facilitated sophisticated gameplay—like in *Utopia*, a real-time strategy game where players select buildings, crops, and boats to develop a flourishing island (figure 2.9).

This distinction between (1) keypad input versus (2) directional wheel and action button input appeared at the level of hardware. The hand controller inputs are read through two ports contained on the AY-3-8914 Programmable Sound Generator chip. Each port registers a byte of data for each controller. Given the design of the hand controllers, the keypad cannot be used simultaneously with the disc and action buttons. Either the port registers action button input using the high 3 bits and disc direction with the low 5 bits, or all 8 bits are used to register keypad input. This constraint, which bifurcated inputs on a hardware level, appears within the aesthetics of Intellivision games on the software level.

These input conflicts caused problems in some games. In *NBA Basketball*, programmed by APh's Ken Smith, players use the keypad to pass in eight different directions. Because the hardware cannot register keypad and directional disc input simultaneously, Smith noted that to pass the ball

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"you had to stop running," which "didn't feel great" since in real basketball players often pass while running. The next game Smith programmed was *NHL Hockey*. In real hockey, players almost never stop to pass. Smith therefore avoided the keypad completely, relying solely on the action buttons and disc. Smith saw himself as "maturing as a user of the controller."

One way around this controller limitation is to use both controllers for a one-player game—one for keypad input and the other for the action buttons and disc. This allows the hardware ports to register all inputs simultaneously. If playing *Tron Deadly Discs* with one controller, players must stop moving (using the controller disc) to throw (using the keypad). Using both controllers—which the manual suggested as a "winning tip"—players can move with one and throw their discs with the other. Similarly, *Microsurgeon*'s manual explains that one player can "steer with the left controller, shoot with the right" or two players can cooperate like a team of doctors operating on a patient: one player controls the Robot Probe while another selects and administers medications. Such possibilities contributed to the sophistication of Intellivision games, creating complex gameplay situations unseen on other contemporaneous systems.

Using the keypad for action games could create other problems. In *Boxing*, for example, players use the keypad to feint and duck, and to punch high, middle, or low with either the boxer's right or left hand. Players have minimal control over moving their boxers in the ring, and the manual even reminds players that they "can work the keys to punch, feint or duck without worrying about the Direction Disc." Players can also string together punches by quickly pressing two buttons in a row. Many contemporary fighting games allow similar sequencing and even button-mashing gameplay. Yet button-mashing was a technical challenge for Intellivision, since the EXEC operating system pauses the game when a player simultaneously presses 3 and 7 or 1 and 9. The manual even warns the player, "Use ONE key at a time" because pressing multiple keys "may cause the screen to go blank."

This compensation reflects broader issues with the controller, which did not always fulfill its promising vision. Sohl noted back in 1980, "I find the hand controller to be difficult to use . . . as well as being unreliable."[86] Consumers were also ambivalent about the controllers: "Some controversy surrounds the controller. . . . It performs beautifully in games like *Major League Baseball* and *NFL Football*, but can be troublesome in hot-action contests."[87] The consumer Research Analyst Cory Schwartz noted that Mattel's own market research team "tested the appeal of the hand controller versus the Atari joystick and it was hands down, people hated the hand controller."[88] A year and a half before Intellivision was released, Hightower spoke with Chang and said, "Please, we've got to do something about these

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hand controllers." While Hightower characterized Chandler's design as "extremely clever," he added that "sometimes clever ideas need to be tossed in the trash can."

Fields of Play

In this chapter we have examined the Master Component from multiple perspectives, including its history, chips, architecture, and even how it was shaped by sports. Mattel Electronics leadership wanted the Master Component to be a sophisticated home videogame console, combining long-lasting gameplay (akin to board games) with striking graphics (akin to the arcades). In many ways, the Master Component itself was bifurcated. Its powerful graphics system, centered on the STIC, stood in tension with its game-logic system, centered on the CP1610 (figure 2.3). Its EXEC operating system facilitated communication between the two systems but slowed the pace of games. Its hand controllers bifurcated action (using action buttons and disc) and strategy (using the keypad). These underlying platform affordances manifested specific forms of gameplay, like Intellivision's sports titles, which combined action on the field with strategic player-as-coach decisions. While not explicitly used in sports titles, one of the most significant aspects of Intellivision game design, called "fields of play," replicated this tension, dividing play situations into a strategy field taking the form of an interactive map and a battlefield where combat takes place. This resembles the distinction between boardgame-style and arcade-style gameplay, but a fields-of-play design combines them in an aesthetic unique for home videogaming, alternating between strategy and action, thought and reflex.

In 1978, Mattel Electronics obtained a license from Universal City Studios to rebrand its *Missile Attack* handheld game as *Battlestar Galactica*, because the original handheld showed missiles raining down on what appeared to be New York City and NBC would not air commercials for it.[89] That June, James wrote a twenty-one-page concept proposal for an Intellivision cartridge based on *Battlestar Galactica*.[90] James envisioned a game that "incorporates strategy as well as tactical play," where players could engage in "the strategy of flying through Deep Space toward an objective or just have fun shooting at enemy fighters."[91] The programmer and manager Bob Del Principe remembered Mattel's marketers asking "for a quick sci-fi game because we didn't have one," and so Del Principe refined James' ideas for these dual playfields, conceptualizing a "first-person point of view 'shooting' game" and developing "the strategy of fighting against different incoming squadrons."[92] The ideas were transferred to APh, where Hightower assigned Hal Finney (the first Bitcoin recipient) to program *Space Battle*—the title

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after the *Battlestar Galactica* license fell through for the Intellivision game. Finney began by creating what Hightower called "a classic target-shooting game." That resulted in something that was fun to play, but the game was sufficiently simple that there was considerable space left even with a 4KD cartridge. Thus, they added James's proposed "strategy play" in the form of a radar screen where players could control squadrons of fighters to defend a mother ship.

Space Battle encapsulates the fields-of-play concept. One section of its manual, "The 2 Fields of Play (Strategic and Battle)," emphasizes that the game "is played on 2 different fields. The strategic field is called the radar screen. The battle field is called the battle screen. During a game you will switch back and forth between these 2 screens." In the game the goal is to protect a mother ship, appearing as a white square in the center of a radar screen. Five enemy squadrons approach from all directions. Players use the controller keypad to dispatch fighter squadrons toward the enemies. As with all Intellivision titles using fields-of-play design, the strategic field includes actual gameplay.[93] When a fighter squadron reaches an enemy, players can switch to the battle screen and engage in arcade-style combat, shooting enemy ships while avoiding their lasers. By design, players alternate between fields of play (for instance, to dispatch a squadron toward different enemies or to enter another battle).

Other Intellivision games used fields of play. In *Sea Battle*, programmed primarily by Smith, the fields of play are called "Battle Phases." In the "strategy phase" players deploy fleets around an archipelago (and can place invisible mines). The complexity of this phase relies on the keypad, which players use to build three-ship fleets by selecting from eight different kinds of ships differing along six parameters (including speed, weapon strength, and weapon range). Players control these fleets by moving them around the islands, with the goal of entering their opponent's harbor on the other side of the map. The "combat phase" zooms in on a portion of the map, enlarging the terrain and ships, where players use the disc and action buttons to control individual vessels—firing on enemy ships, using islands to avoid fire, even running aground and sinking. Indeed, Intellivision's BACKTAB structure (figure 2.7) allowed Smith to track which map card the battle would occur on, and then using a lookup table, quickly assemble an enlarged, predefined version for the combat phase.

Space Spartans, programmed primarily by Mattel programmers William Fisher and Stephen Roney, also used fields of play. The strategy field ("sector grid") consists of a 16×8 grid—leveraging Intellivision's background grid—where players can see three enemy starbases, place their own, track enemy movements, and engage the enemy. Combat takes place in "battle view,"

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which resembles the battlefield in *Space Battle*. *Space Spartans*'s "sector grid" field of play recalls the "Galactic Chart" in *Star Raiders*, a videogame for Atari 8-bit computers released in 1979.[94] However, James's "Battlestar Galactica" strategic view predates *Star Raiders*, and map-like grids had been circulating for several years.[95] Fisher and Roney knew of *Star Raiders*, but both were avid boardgamers and Fisher noted "a lot of the thinking processes that went into what we did came from the board game world." Together with Sohl, Fisher and Roney also used fields of play in *B-17 Bomber.* In this case, the strategic field shows a map of Europe with targets; the combat fields are where players engage enemy planes and bomb the targets.

In *Advanced Dungeons & Dragons* (*AD&D*), programmed by Loughry and others at APh, fields of play are called the "strategy map" and "cave system." The strategy map shows mountains, forests, rivers, and walls with locked gates. The different color of the mountains indicates what treasure any particular mountain contains (for instance, a boat or ax). This changes each game. *AD&D* thus has a dynamic strategic field that changes gameplay. To achieve this, Loughry used a linear congruential generator algorithm: "You can take a number space and mix it around all you want. And by very carefully doing that, you can come up with some acceptable results that will give you a fairly random universe that's different each time." When entering a mountain in the cave system (also randomly generated), players control a hero shooting enemies in a series of rooms. Yet again, fields of play entwine. For instance, the boat and ax, collected in the cave system, allow one to cross rivers and forests on the strategy map.

One academic assessment of Intellivision at the time explained that the console's "forte, according to industry observers, is games with detailed but static displays."[96] Because the STIC and BACKTAB structure allowed the quick construction and display of different screens, detailed strategy fields like *Space Battle*'s radar screen, *Space Spartan*'s sector grid, and *AD&D's* strategy map could be easily added and integrated into gameplay. Thus, fields of play partially emerged because of the platform's affordances.

The fields-of-play concept was a striking feature of many Intellivision games. The concept drew inspiration from board games and the domestic sphere. It was distinct from sports titles but also distinct from arcade gameplay. Arcade games typically used "single screen play," where "the player, at any time, is able to see the entire game-world."[97] This accelerates decision making—important for time-limited arcade situations. In contrast, fields of play require additional play time: decisions cannot always be made quickly and without maneuvering between two screens. In *Sea Battle*, for example, players must switch from strategy phase to combat phase to ascertain what kinds of ships make up an opponent's fleet, perhaps choosing to retreat if

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an opponent's fleet is too strong. This complex alternation between fields of play requires a temporal engagement and duration incompatible with arcade games but appropriate to the home as a location for extended leisure.

Like sports videogames, the fields-of-play concept contributed to Intellivision's aesthetics of intelligence, reflecting the historical juncture of board and arcade games. Rather than resolve these forms of gaming, fields of play unified them, representing a hybrid, transitional form of videogaming entwining strategy and action. In doing so, it reflected the vision of Mattel Electronics and Chandler for new forms of long-lasting play now possible in the domestic sphere. The fields-of-play concept was also predicated on the capabilities of the Master Component, from the hand controllers to the STIC and the background grid structure. Along with Intellivision's sports videogames, fields of play encapsulates how the console was developed—from initial ideas at Mattel Electronics through a broad set of collaborations—to elaborate new, sophisticated forms of gameplay. The Master Component, the true "heart" of Intellivision, defined the system and its gameplay. It thus helped define the second generation itself, and the new possibilities for videogames that were coming into being—and into the home.

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The Keyboard Component

3

In November 2020, "decle" posted a message and video to *AtariAge*, an online forum for retro gaming enthusiasts: "BIG news, we have gotten a commercial tape working on Ron's K/C! We can now have hours of fun with *Crosswords 3.*"[1] "K/C" refers to the Keyboard Component, which turned Intellivision into a home computer. The news about getting one to work mattered because it is one of the rarest machines in the world of vintage videogames. Only around four thousand Keyboard Components were made, and almost all were destroyed, repurposed, or recalled. In a later video, decle demonstrated software connecting the Keyboard Component to a modem. This allowed posting on the *AtariAge* forum "a proof of concept that Mattel could have done something similar in the 1980s if the Keyboard Component had made it beyond test marketing."[2]

Those familiar with Intellivision likely know it only as the Master Component, a videogame system that competed against the better-known Atari. However, from its inception, the Keyboard Component was central to Intellivision's philosophy, development, and marketing. Analyzing hardware and software that sold poorly, or was never released or completed, extends beyond winners and best-sellers to illuminate broader platform dimensions—for example, how second-generation videogame systems were caught up in the emergence of home computing and the platform futures of domestic technology.

The rise of home computing in the late 1970s fundamentally influenced Intellivision. As noted in the last chapter, one can detect this influence on the Master Component itself—for example, with the console's complex hand

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3.1 The Keyboard Component, with the Master Component inside it (image from the 1979 Intellivision catalog).

controllers with twelve-button keypads. But engineers and marketers also envisioned platform futures where Intellivision would be far more than a videogame console. In October 1978 Jeff Rochlis, who became President of Mattel Electronics the same month, referred to the "Master Console" as part of a broader system whose other major element was an "Add-On Module" that would become the Keyboard Component.[3] What became known as the Master Component would be placed entirely inside the Keyboard Component, attached by a ribbon cable running into the console's cartridge port (figure 3.1). Regular Intellivision cartridges could be played on the combined system, but the Keyboard Component promised much more. One of the first brochures for dealers and buyers explained, "Intellivision is a system of modularized hardware components and a broad spectrum of software that offers consumers a choice of purchase options and benefits." Videogames do not appear in this description because the idiosyncratic Keyboard Component was intended to expand Intellivision far beyond the world of videogames.

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By the late 1970s, a debate was underway regarding how videogame systems might compete with, or even become, home computers.[4] Home computers were also based on a distinction between hardware and software, and even the earliest could play games. Computer manufacturers were "trying hard to make users comfortable by avoiding overly technical concepts and jargon while stressing ease of use," and games helped with this acclimation.[5] In October 1977, Rochlis was quoted in the *Washington Post* stating that Mattel's handheld games were "fore-runners of the home computer," asserting, "One way to get into the home-computer market is to sell games. Game play is one set of software. We'll see home systems in five years that not only play games, but also store financial records, run the home security system and turn the appliances on and off."[6] Even as Intellivision's development was in its infancy, electronic games were seen by leadership as a pathway to domestic computerization.

Executives like Rochlis were crucial in convincing reluctant corporate leaders such as Mattel's Chairman Art Spear and Mattel Toys President Ray Wagner to support the Intellivision venture and the expansion into home computing. Rochlis, a flashy salesman and marketer, ceaselessly promoted Intellivision as an opportunity for Mattel to shape the emerging digital world. Glenn Hightower, whose company APh designed the digital circuitry for the Keyboard Component, emphasized that Rochlis convinced "Mattel to open the purse strings and actually do something. He got them into the whole Keyboard Component." Tom Kalinske, Senior Vice President of Marketing at the time, agreed that Rochlis "taught me a lot about the whole idea of Intellivision being more than a game machine in the home."

Ed Krakauer, who headed Mattel Electronics early on and hired Rochlis, said that the idea for the Keyboard Component "was an evolution" that emerged as leadership visited events like the Consumer Electronics Show (CES) and absorbed ideas from the industry. The idea that home computing would arise from consoles was in the air at the second generation's outset. For instance, when Fairchild's Video Entertainment System—the first console using cartridges—hit store shelves in late 1976, management touted that "it is expected to evolve into a home computer."[7] Even Rockwell International, with whom Mattel was collaborating to make handheld games, made a splash demoing its "Videospond" system at the Summer 1976 CES—with keyboard, joysticks, and cassette drive promising sophisticated "thought games" and applications for health and fitness.[8] At the January 1978 CES when Mattel Electronics privately demoed its nascent videogame console, "Atari & Bally showed computer-like add-ons" for their game systems while home

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computers "generated plenty of excitement" but with "confusion over market direction."[9] The industry was questioning several things. Should home computers use dedicated displays (like the Commodore PET) or television sets already in homes? Should videogame console extensions simply increase their entertainment value, or turn them into home computers programmable by consumers? Should software be preprogrammed or "designed for modification by user?"[10] At issue were competing platform futures. Would consoles incorporate computers or the other way around?

One response to these futures was to turn consoles into computers—the path Mattel Electronics followed with Intellivision. In December 1978, leadership officially announced that Intellivision would have a $230 videogame base system and a "modular add-on" that would "turn it into $500 game-computer." (Atari largely went the other direction, announcing their 400/800 home computers that would play video games.[11]) A report from the January 1979 CES concluded, "Computers are up, video games are down, but combination of both is really where it's at. Surprise introduction by Bally of computer add-on to $300 video game paralleled expected debut of Mattel game-computer."[12] The home electronics industry was enamored with videogames but also expanding beyond them.

The Keyboard Component cemented an approach where modular extensibility became a key aspect of Intellivision's story, adopted from the home computer and consumer electronics industries. With its promise of flexibility, longevity, consumer choice, and expanded functionality, modular extensibility was a feature of mid-1970s computers like the Wang 2200 minicomputer, which had peripherals including disk storage units, cassette drives, terminals, printers, and plotters. Kit systems like the Altair 8800 allowed for expansion, as did the Apple II and Commodore PET. Expandability existed for even the earliest home videogame systems. As far back as 1976, an observer could conclude that "optional peripheral equipment such as tape drives, printers, and keyboards will increase the flexibility of the game console dramatically."[13] For example, the Atari VCS could switch between joysticks and paddle controllers, and the optional CX50 "Keyboard Controller" functioned similarly to Intellivision's keypad controllers.[14] In later chapters we examine other extensions released for Intellivision, but the Keyboard Component was the first and most complex, founding Intellivision's identity as an expandable system.

While the influence of home computing was important, Mattel Electronics also embraced modular extensibility to compete in the videogame marketplace. A marketing presentation from 1983 noted that "initial Intellivision owners bought the [Master Component] on the promise of future expandability, and until early 1982, expandability was an advantage

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consumers gave Intellivision over Atari."[15] Instead of having to choose between Atari's cheaper videogame console or an expensive Atari home computer, one could choose Intellivision at a middle price. Intellivision marketers assured consumers they could expand the system into a home computer in the future, while enjoying a more advanced videogame console now. This strategy made Intellivision an appealing option—though, as we shall see, also led to legal problems when Mattel Electronics failed to deliver the Keyboard Component quickly.

Strikingly, Intellivision's modular extensibility was articulated through the language of stereos. A technical description from 1979 began, "Intellivision is a modular system which can be purchased one component at a time."[16] As part of his advocacy for the Keyboard Component, Rochlis contended that "the consumer is not ready to embrace the home computer concept yet so we designed our product on a component basis. We will give the consumer the opportunity to buy into something at a lower price and then have the option to expand the system."[17] This language of "modular" and "component" articulated expansion in terms of the stereo. One reporter emphasized, "Rochlis draws an analogy that Intellivision can be purchased like a stereo system. Stereos come in component form, such as the receiver or amplifier, turntable, tape deck, and speakers. Consumers are able to purchase these separately."[18] Home computing was the destination, but stereos, a quintessentially domestic technology, were the metaphorical path to that destination. As with gaming, this analogy familiarized consumers with home computing.

Seen in the context of consumer technology and the early home computer industry, the Keyboard Component was not a radically new idea. It built on the excitement surrounding the market potential of hybridizing videogames and computers. Through the modular combination of the Master Component and Keyboard Component, a computer could arise on the platform foundation of a console. This is evident on the first page of the Keyboard Component's manual, which stated that after fitting the Master Component into the Keyboard Component, "your Intellivision home computer is ready."

Papa Keyboard Component

When decle posted the announcement about a working Keyboard Component on *AtariAge*, someone responded, "I wonder what Dave 'Papa Intellivision' Chandler would have thought about this."[19] As described in the previous chapter, Chandler was a Mattel Electronics engineer who led Intellivision's development. While Chandler has been called "Papa Intellivision," many would see the moniker as inaccurate, given all those involved

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in the conception and development of the Master Component. However, there would likely be less hesitation dubbing Chandler "Papa Keyboard Component." While others at Mattel Electronics, APh, and General Instrument (GI) contributed to the conception and development of the Keyboard Component, the extension was deeply influenced by Chandler's thinking and career.

Chandler had an engineering background that included working at Autonetics, a division of North American Aviation. This work included submitting proposals to the Department of Defense. Chandler's son Alan recalled hearing how these proposals required "twenty copies and they all have to be exactly the same and they all have to be correct." Another son, Paul, remembered Chandler concluding "there's got to be a better way that I can type and when it's all done print up a completely clean document, even though I'm only going to change one word." To solve this problem Chandler developed "what would now be called a word processor system."[20] In November 1967, Chandler filed a disclosure for the "Self Contained Editing System," shortened to SELF-EDIT.[21] North American Aviation allocated $50,000 to prototype the device, consisting of an IBM Selectric typewriter, cassette drive, and "control and temporary storage unit" (figure 3.2).

SELF-EDIT was truly a hybrid machine—half mechanical typewriter, half digital computer (figure 3.3). Chandler inserted sensors into the typewriter that allowed the digital control unit to record the binary coding of each keystroke, store the data on a cassette drive, and then play back the keystrokes.[22] Chandler's daughter Elaine Smith called it "one of the forerunners of word processing." To use SELF-EDIT one would first insert a piece of paper in the Selectric. Pushing the "attention key" (added to the right side of the typewriter) signaled the control unit to begin recording and you could type normally. The temporary storage unit would allow deleting and inserting text, then saving the edited line to the cassette drive. As with normal typewriters, Paul recalled, "if you made a mistake you'd backspace and it would type over top of the word," but the control unit would store the corrections. Alan added that the typed-over words would soon become illegible, but "then you could click in a fresh piece of paper and push a button on the control unit to tell it to print, and the typewriter became a printer and printed your document."

After North American Aviation terminated SELF-EDIT in November 1969, Chandler left with the intellectual property rights to form Chandler Business Machines with a colleague, Chuck Henry. For seven years they worked unsuccessfully to bring SELF-EDIT to market, targeting a corporate clientele (as reflected in the proposed $6,500 price).[23] However, Chandler grew increasingly interested in the domestic market. Paul recalled how

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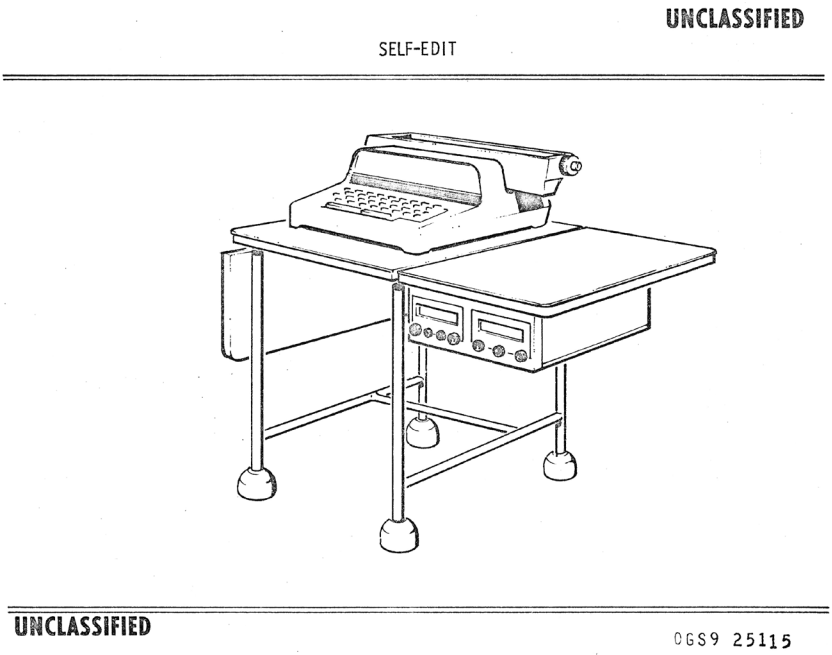

3.2 Proposed design for SELF-EDIT (David Chandler, "SELF-EDIT Pitch Deck," 1970, Paul Chandler archive, 1).

3.3 SELF-EDIT machine (Paul Chandler archive).

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Chandler became convinced that SELF-EDIT's fundamental flaw was the lack of a video card to drive a cathode-ray tube (CRT) monitor.

To gain revenue for Chandler Business Machines and learn about video technology, in 1976 Chandler signed a contract with a European company, Video Play International (formerly Hiland-Gorgie International), to develop an arcade game based on the F8 chip produced by Fairchild Semiconductor.[24] The resulting videogame, *Tank Squadron*, was an achievement in its own right (figure 2.1), but Paul emphasized that Chandler's "whole motivation for going into videogames was the video card systems, a high-quality way to drive a CRT where you have the capability of having background memory and being able to change only a small part of the image and still be able to refresh the screen rapidly." Despite the *Tank Squadron* contract, Chandler Business Machines went defunct in 1977, and Chandler applied for a position at Mattel.

SELF-EDIT is unknown in the history of technology, including histories of word processing.[25] For Chandler, the Keyboard Component was partially the spiritual successor to SELF-EDIT, with the Master Component acting as the missing video card. Alan noted that Chandler "had a lot of fun designing Intellivision, but I think in the back of his mind it was a stepping stone to the Keyboard Component. To see a cassette tape drive inside the Keyboard Component was no surprise to us. He took all the knowledge he gained from SELF-EDIT and put it into the Keyboard Component." Similarly, Paul recalled that "we had a conversation of why he was doing the videogames. And what was quite clear was that his interest was getting computing capability into the home at a reasonable price, and he dropped the Master Component into the Keyboard Component as the video card."

Chandler's task at Mattel was to develop a videogame system. The job advertisement did not mention home computers. However, in sworn testimony from 1982, Chandler explained that using the Master Component as the "base" for a modular system and home computing was "a very early objective of the program."[26] Chandler's experience with SELF-EDIT and videogames made him ideal for managing the project. Chandler recounted how when he was hired, Intellivision "as it was presented to me really just first had to do with the idea of what a home video game ought to be. . . . From that point on, I was primarily the one defining what the Intellivision system was, what the concept for expansion was, the concept of it being a modular system that could be expanded into doing other things in the home."[27] Chandler consistently articulated this position—for instance, stating in 1982 that "video games (entertainment) will always be the heart of home systems but are dead ended as a stand alone product. Video games provide [the] best base for home computers."[28]

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The Keyboard Component was envisioned to launch a future of self-improvement, home productivity, and networked communications that would connect domestic and public spheres. This vision was shared and promoted by early Mattel Electronics leadership including Krakauer and Rochlis. In a memo to Krakauer, Chandler envisioned Mattel Electronics participating in "home data communications" as "the next major revolution to affect the American way of life," adding that "because it is home centered and involves entertainment, self-improvement, and the whole family, Mattel Electronics should play a major role. The question is what role?"[29] Rereading this memo in a later interview, Krakauer recalled agreeing with Chandler: as home computers increasingly entered the market, companies "were advertising, 'Why buy a videogame when you can buy a computer?' The writing was on the wall. I urged Art Spear to have Mattel get into the computing business."

For some, the idea of the Master Component being dropped in as the video card for a home computer was troubling. Mattel engineer Brian Dougherty noted that the Keyboard Component was internally dubbed the "Blue Whale" because it swallowed, Jonah-like, the console. While the Keyboard Component could be interpreted as extending Mattel's electronic games business in exciting new directions, it could also be seen as engulfing and suffocating it. In January 1976, Richard Chang's group in Preliminary Design had originally envisioned a console to play sports, driving, and strategy videogames, and even feature "etch-a-sketch" style drawing (figure 1.1). Intellivision was to extend Mattel's traditional business in toys and games. There was no mention of a keyboard or computing. With the hiring of managers like Rochlis and Krakauer and engineers like Chandler, the early games-centric focus of Chang's group and Mattel's history with toys became increasingly overshadowed. Hightower, who worked closely with Chang, remarked that the Keyboard Component was "something Jeff Rochlis wanted to do, something Dave Chandler wanted to do, but something Richard Chang did not want to do."

Chandler originally worked for Chang, but unlike Chang, Chandler was oriented toward computing rather than play. Chandler had never created a toy, and when hired into Preliminary Design—the hothouse of Mattel's innovation with its focus on play value and cost cutting—Chandler immediately set to work on Intellivision. Chandler's experience before Mattel had been with aerospace and corporate clients. (Even *Tank Squadron* was developed primarily to help finance Chandler Business Machines and test video technology.) Ultimately, Chandler's past experiences conflicted with the cost-aware toy industry. For example, Laury Scott Jr., an executive at the company Radofin, which eventually manufactured Master Components,

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recalled Chandler's insistence on using expensive, thick gold plating (around twenty microns) for the Master Component's cartridge slot. Scott emphasized that this was "the type of plating they used in aerospace. You can't have a plane go down." He argued for five microns, stating to Chandler that it would take thousands of uses to wear down the connection. After having production staff insert game cartridges into Intellivisions 10,000 times to confirm sufficient thickness, Scott was able to convince Chandler: "Unlike some engineers, he was open to this kind of conversation."

However, the Keyboard Component was expensive and complicated, consistent with Chandler's history in aerospace and the rejection of consoles as standalone products. As Intellivision developed, Chandler became further distanced from Chang and Preliminary Design, becoming Director of Product Engineering with his own group. Eventually Mattel Electronics would split organizationally, with Chang directing the toylike handhelds and software for Intellivision while Chandler managed hardware development, including the Keyboard Component. By the time Chandler began working earnestly on the Keyboard Component, he was outside of Chang's purview and further afield from the influence of Mattel's institutional history with toys.

A Convoluted Component

The Keyboard Component was vastly more challenging than anything Mattel had attempted, ten times as complex as the Master Component by one estimate, and its development required coordination between Mattel Electronics, GI, and APh.[30] In November 1978, a year and a half after Chandler had been hired to lead the Intellivision project, Mattel Electronics and GI were trying to decide how a computer add-on could be configured to work with the Master Component.[31] The proposed device would include a peripheral microcomputer built around an additional CP1610 microprocessor used to access a cassette drive and communicate with the Master Component's CP1610 through a shared memory space. The add-on would feature a keyboard, a microphone, a cassette drive, a cartridge port, peripheral ports, a high-resolution character generator for text, and 16KD of 10-bit RAM accessible by both CPUs.

GI engineer Stephen Maine quickly began to have reservations about this proposed system architecture. In particular, commands issued by the CP1610 for conditional branches were unpredictable, making it "almost impossible to time-division multiplex the system bus or ever momentarily stop one of the CPUs until synchronism is again possible."[32] In other words, it was difficult to avoid errors and timing conflicts when synchronizing two

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CPUs addressing a shared memory space. Since Mattel Electronics leadership wanted to produce the component quickly, Maine recommended GI withdraw from developing "the desired home computer add-on. Any system that is designed in such haste is likely to have many pitfalls and will inevitably result in a poorly compromised end product that is late in delivery and neither competitive nor cost-effective."[33] Maine's prediction would be remarkably prescient.

Despite these concerns, GI continued to collaborate with Mattel, and a technical workshop was held January 15–17, 1979, at GI's offices in Hicksville, New York, including engineers from Mattel, GI, and APh.[34] While progress was made, a major problem was that the Master Component's video controller, the STIC, was designed for graphics, not text. Chandler's dream to use the Master Component's video chip for word processing became a nightmare. GI engineer Duncan Harrower tried to convince Chandler's team that "the architecture was for playing games. It was designed to move multicolored objects around. It wasn't for putting alphanumeric characters up on a CRT screen." Harrower emphasized that "the architecture just doesn't work as a home computer. It was never designed for that," adding, "If Mattel had said, 'Look, what we're trying to do is a home computer,' we'd have started with a totally different set of chips than the STIC chip. I was asked, 'Could you put 40 characters across the screen?' I said, 'Not a hope.'" By June, GI had backed out of the project.[35]

To be commercially viable as a respectable home computer, the Keyboard Component needed to generate at least 40×24 characters onscreen. The Master Component's 20×12 background grid would display text at half the resolution of home computers (like the Apple II) and would be drastically limited—unable, for instance, to display lines of text more than twenty characters long. After the January 1979 workshop, GI implemented an alphanumeric character generator to produce the desired onscreen text, but by the end of the year, Chandler's team decided to use a 5037 CRT video controller from Standard Microsystems Corporation (a rebranding of Texas Instruments' TMS9927).[36] Ultimately, the text display from the 5037 CRT is fed to the Master Component and "overlaid on the STIC's current display output."[37] Thus, the STIC displays Master Component graphics while the 5037 CRT handles the Keyboard Component's higher-resolution text. In a demo of the unreleased "Super Football" cassette, the score appears as higher-resolution text above the football field generated by the STIC.[38] The graphics and text created a jerry-rigged hybrid of text-based computer and graphics-centric console, reflecting divergent visions for Intellivision's platform future. Just as the Keyboard Component engulfed the Master Component physically, the overlaid text belied how Chandler superimposed a

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vision of computing on top of Mattel's early desire to create a videogame system.

The addition of the 5037 CRT to display text was not the only idiosyncratic element of the baroque Keyboard Component. When Chandler switched to the 5037 CRT in late 1979, he replaced the second CP1610 inside the add-on with MOS Technology's 6502 microprocessor, found in many consoles and computers at the time. The 6502 controlled the add-on's built-in cassette drive for program, data, and audio storage, which was also a bespoke component with digital tracks for programs (read-only) and program/data storage (read-write), and analog tracks for prerecorded audio (read-only) and recording microphone audio (read-write). The keyboard itself, described in a handwritten note from Chandler as a "full typewriter-like keyboard," reflected SELF-EDIT's influence, although it contained keys with unique functions like clear screen, repeat, and arrows for moving the cursor.[39] The add-on even included a microphone to record one's voice on the cassette drive.

However, the Keyboard Component was not created in response to a specific consumer demand. Legions of families were not clamoring for microphones attached to computers or hi-tech devices to balance their checkbooks. For Chandler this was irrelevant: the consumer "doesn't know what he wants. We must decide what makes sense and then go educate the consumer."[40] Yet deciding what made sense for home computing in this nascent period was not obvious. Josh Denham, who became President of Mattel Electronics in 1980, noted that "the Keyboard was a passion of the development guys" but "in those days, nobody was quite sure what a computer did." Denham recalled that as Chandler's team developed prototypes, "every month or two they'd bring it in and say, 'Okay, now we've got it down to this point, and it'll do this.' And I said, 'Well, what does it cost?' Oh God, the cost was unbelievable. Just totally out of the range of anything that you could sell."

Transforming the Master Component—designed for games—into a home computer was an arduous, convoluted, and expensive process, undertaken during a time when home computing was equally opaque and uncertain. While originally planned for release with the Master Component, the Keyboard Component fell behind schedule. During the Master Component's test marketing in late 1979, a six-minute demonstration cassette explained the combination of Master and Keyboard Components, assuring consumers that the Keyboard Component would be available the following year. However, it was almost a year later—September 1980—that the Keyboard Component entered limited test marketing "with national distribution

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planned for the beginning of 1981."[41] It retailed for $700, more than twice the cost of the Master Component.[42]

When users powered up the Keyboard Component, what they saw was surprisingly simple: a green screen with white text displaying "Intellivision" and "Intelligent Television" in smaller text below. Another line read "for index, type 'I,' then RETURN," followed by a > symbol and blinking cursor. Typing "I" brought up options including TAPE (to start a cassette program), CARTRIDGE (to start a game cartridge produced for the Master Component), and SCREEN (to enter Typewriter Mode). The manual encouraged users to begin with Typewriter Mode since "the best way to get thoroughly familiar with your keyboard is to play with it." Typewriter Mode allowed users to enter text and insert special characters to draw images. More importantly, it partially realized Chandler's dream of SELF-EDIT on a CRT screen. "Fill up the screen, then erase it and fill it up again," declared the manual: "The nice thing about Typewriter Mode is that once an image is off the screen, it is gone for good." While Chandler had "pushed to have a word processor included" with the Keyboard Component, Rochlis blocked the idea because it seemed too office-like.[43] Yet with Typewriter Mode one can imagine Chandler sitting before the Keyboard Component, filling up the screen with text and deleting it, satisfied at last.

A Software Player

The Keyboard Component was far more than a virtual typewriter. Though Chandler's history with business computing influenced the add-on, both he and Rochlis did not want to foreground business applications or even user programming.[44] Mattel Electronics did pay Microsoft $30,000 to license and modify BASIC for the Keyboard Component.[45] However, this cartridge was an optional purchase, reflecting Mattel Electronics' embrace of modular extensibility and the fact that the component was intended "primarily for non-computer people."[46] Nor would the Keyboard Component focus on videogames—the Master Component was the game platform. Instead, self-improvement, home finances, and education were emphasized. One observer called the Keyboard Component "a departure from other home computer systems because it offers a library of software cassettes which are designed for application by the entire family."[47] Intellivision's first television commercial showed a husband, wife, and son using the Keyboard Component while a voiceover said, "Soon the John Guyer family will be using their TV to help compute their federal income tax, learn French, improve math skills, and quarterback an NFL team." Gaming appears last in this list.

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Few software programs were released during test marketing for the Keyboard Component. Every cassette was developed by APh save *Geography Challenge*, programmed by Don Daglow, an employee of Mattel Electronics. Eventually, five cassettes required the optional BASIC cartridge: *Crosswords I*, *II*, and *III*, *Geography Challenge*, and *Family Budgeting*. These BASIC titles leveraged the alphanumeric affordances of the 5037 CRT but could not use the Master Component's graphics.[48] Other software included *Spelling Challenge*, *Conversational French*, and *Jack LaLanne's Physical Conditioning*.[49] The only completed games for the Keyboard Component were the *Crosswords* titles and *Geography Challenge* (if considered a game), although "Super Football" was in development. Since games were not the focus—nor user programming or business applications—what was the vision behind the Keyboard Component?

In September 1978, around the time the "Intellivision" name first appeared, Ed Sack (a Senior Vice President at GI) circulated a memo hypothesizing that "there is going to be another 'box' in the typical consumer's living room" that will provide "a rich selection of information, entertainment and education."[50] This was not a personal computer, but something different. Teletext systems had recently emerged in the United Kingdom, delivering information to televisions. Sack predicted that US consumers would instead purchase preprogrammed software for use on home systems, without an emphasis on user programming. Sack's idea was that the "cassette-programmed Home Information System attached to the color television set fills a nitch [sic] for the consumer between the 'dumb' capability of the simple programmable video game and the full range video capacity of the more expensive high speed video tape player."[51] The expensive video tape player Sack likely had in mind was the videocassette recorder (VCR)—which could retail for $1,000 and provided high-quality recorded images. Sack not only placed videogame consoles on a spectrum ending with computers, but also videotape machines and VCRs.

Sack called this imagined device a "software player," evoking the modular world of home stereos with tape and record players, and even televisions with VCR players. While the Keyboard Component turned the "Master Component into a valid home computer" as Chandler wrote, it also turned Intellivision into a device akin to Sack's software player.[52] This idea was manifest in the Keyboard Component's use of cassettes, which brought distinct possibilities to the system: storage was transformationally greater than a cartridge, but access was slower. A cassette could store more than seventy-five times the program data and graphics of a standard 4KD Intellivision cartridge. Indeed, an "easter egg" discovered in *Conversational French* was 1.5KD, nearly half the capacity of an original Intellivision

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cartridge.[53] With such massive storage capacity, the Keyboard Component could accommodate rich audiovisual experiences.

David Rolfe, an APh programmer who wrote the Master Component's EXEC operating system and was deeply involved with the Keyboard Component, understood that developing cassettes for the add-on required rethinking the Intellivision platform. Rolfe designed a program named PicSe, "Picture Sequencer," which would assist the creation of rich audiovisual cassettes.[54] PicSe fundamentally reshaped the use of Intellivision's hardware, particularly the STIC, revealing that the technical structure of a platform can be used for radically different purposes. Indeed, PicSe deemphasized moving object support, privileged by the Master Component, in order to support more dynamic backgrounds with cassette programs. How did this work?

The Master Component contains 512 bytes of graphics RAM (GRAM) available for programmer-created graphics. As described in the previous chapter, there are two key issues with the use of GRAM. First, it is limited. GRAM can store up to sixty-four unique graphics cards that the STIC can use to display both moving objects and background cards. A trade-off emerges: the more GRAM space used for moving object cards, the less available for programmer-defined backgrounds and vice versa. Second, changing GRAM cards is not trivial. GRAM is only accessible when the STIC is not actively drawing the current frame—during vertical retrace of the television's electron beam. It is also the only time that programmers can update Intellivision's eight moving objects, including their GRAM cards to sequence animations. Thus, if a videogame uses moving objects extensively, then as Rolfe explained in the PicSe documentation, "there is normally no time for dynamic GRAM-loading."[55]

The Master Component's EXEC operating system solved this issue "by allowing GRAM to be loaded only once, when the game is initialized."[56] Programmers could load their graphics from the cartridges and associate them with moving objects or background cards, but reloading GRAM would require rebuilding the background completely. Moving object support is essential to videogames, from interactive opponents in a sports game to enemy alien ships shooting laser beams. As a result, Rolfe programmed the EXEC to manage and dynamically change GRAM cards to facilitate moving object animations. However, the EXEC does not support dynamically changing GRAM cards for use in the background during gameplay.

As programmers became more familiar with Intellivision's hardware and the EXEC, they learned how to change and animate background cards just like moving objects, a technique called GRAM sequencing. When drawing the background, the STIC fetches a graphics card from GRAM identified in

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the background table (BACKTAB) entry for the card (see chapter 2). Periodically changing the BACKTAB entry to point at a different card already stored in GRAM, or changing the card in GRAM between frames that the BACKTAB entry points to, will animate the card. Tom Loughry used the first technique in *The Dreadnaught Factor*, noting that "when the little guns fired, it changed from one GRAM image to another GRAM image just by changing the tile pointer." This creates the illusion of movement in the same way as frame-based animation for moving objects, and the programmer does not need to reload GRAM to do so. Keith Robinson's *Tron Solar Sailer* used GRAM sequencing to create a vibrant background with enemy towers and flowing energy beams. Rick Levine's *Microsurgeon* used this technique to animate cholesterol and pathogens flowing within a patient's body. Programmers could also bypass the EXEC operating system and change GRAM cards on their own during vertical retrace, although Rolfe wrote that this "is a tedious process, and requires meticulous planning if it is to be done without causing annoying flashes on the screen."[57]

Sequencing GRAM led to more active and dynamic backgrounds while allowing programmers to skirt Intellivision's limit of eight moving objects. For example, in *Masters of the Universe: The Power of He-Man* the player must dodge or block many lightning bolts, and in *Worm Whomper* players protect a field of corn from an invading army of worms, snails, slugs, and moths. In both videogames, the screen is alive with multiple threats, far greater than the number of moving objects supported by hardware. These additional objects are not moving objects but background animations created by sequencing GRAM.

In contrast, the self-improvement cassettes for the Keyboard Component like *Conversational French* were not imagined as videogames: they did not need extensive moving object support with fast animations (figure 3.4). As Rolfe wrote, "Add-On cassettes, in contrast to the game cartridges, will generally display many scenes and backgrounds in a single cassette. It becomes readily apparent that a single cassette will be forced to reload GRAM many times as it displays new scenery."[58] For example, in *Conversational French* a sequence teaching about food and restaurants shows a large image of a street and cafe with cars driving in front, followed by images of a ham, mushrooms, and cheese, a woman eating, a faucet, a man drinking, a wine bottle, and so on. Each of these images was different, necessitating reloading GRAM.

Thus, Rolfe flipped the philosophy of the Master Component's EXEC. Instead of loading GRAM once and privileging moving object support like in many Intellivision videogames, PicSe handled dynamic GRAM allocation

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3.4 Promotional images of *Conversational French*.

for both background graphics and moving objects. Indeed, PicSe allowed creating "blocks" of moving objects into a "combined object" that could then be moved as a single unit—likely the cars moving in front of the cafe in *Conversational French*.[59] Moreover, moving objects could be used to add a bit more color or higher-resolution details to the scenes when overlaid on the background graphics.[60] While the STIC hardware draws the display sixty times per second, and the EXEC updates moving object positions twenty times per second and moving object animations fifteen times per second, PicSe can update and change the entire screen ten times per second—slower than needed for a peppy videogame but fast enough to create less interactive animations. Since changing GRAM is difficult and needs to be done precisely, a programmer could now define their graphics and different screens, and PicSe would handle the necessary work to make sure these graphics were allocated correctly.

APh described the software they created for developing Keyboard Component cassettes as generating an "animated picture sequence" and allowing programmers to "sequence through a short series of scenes" or "get a feel of the action of a sequence as well as a static scenario."[61] This language of sequences, scenes, and scenarios aligns with cinema rather than videogames. Rolfe noted that while the EXEC involved "keeping track of the objects" for games, using PicSe on the Keyboard Component "was more like an interactive movie." Intellivision became less of a videogame machine or a user-programmable home computer and instead pointed toward a platform future of computers delivering audiovisual content.

As with the Master Component, where licensing for games like *Major League Baseball* was seen as crucial, Mattel Electronics obtained licensing arrangements for several Keyboard Component cassettes. A difference

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was that these licenses were negotiated with expert individuals. A similarity was that the licensors were not involved in development. Mattel's Joey Silvian was originally hired from the American Film Institute to write scripts for *Jack LaLanne's Physical Conditioning*, "Jeane Dixon Astrology," and other Keyboard Component cassettes. Silvian recalled how LaLanne, a fitness celebrity, recorded a script but never used a Keyboard Component: "We hired someone from the University of Michigan to be the physiological consultant" and design the fitness program.[62]

There was one exception to this arms-length relationship with cassette collaborators—*Conversational French*, developed with Alouette Language Service. Based in Santa Monica, this language learning company was founded by Bill and Mimi Schroeder and linked to the Southern California local industrial system. In addition to work with movie studios, Mimi recalled, "in those years the defense department was giving lots of contracts here in Southern California." Alouette had provided language training for military contracting companies like Lockheed and Hughes. In 1980 Diane Kissell, Vice President of Marketing for Video Products, saw an advertisement for Alouette and invited them to Mattel with the possibility of collaborating on language cassettes.[63] To storyboard a French language course, Mimi recalled deciding "we're going to do a traveler's course called 'Going to France.'" Kissel was impressed and finalized a deal. The resulting cassette used Mimi's voice and likeness. Rolfe, who helped program the cassette, emphasized that synchronizing Mimi's speech and animated mouth was a major achievement. Using PicSe, APh programmers could construct remarkable graphic sequences, tightly coupling images with audio.

In the context of the early 1980s, Intellivision was breaking new ground with its cassettes, potentially serving it well in a context of emerging rivalry. For example, in 1980 Atari released conversational French and Spanish cassettes for their 400/800 computer systems. Created in part by Gabriel Baum before he moved to Mattel Electronics to direct videogame development, these cassettes shared themes with *Conversational French*, but they did not have impressive moving graphics or the ability to record the user's voice. Indeed, Intellivision's cassettes changed the conversation around design and constraint. Media-rich applications like *Conversational French*, with its animated, full-screen Mimi and lip-synced voice, illustrate how the Keyboard Component foregrounded interactive digital applications less limited by memory constraints, predating the 1990s rise of media-rich CD-ROMs and contemporary bloated videogames with massive cutscenes. The Keyboard Component, less of a videogame machine and more of a software player, foreshadowed the emergence of the computer as a media machine.

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An unreleased commercial for the Keyboard Component drew on an Intellivision advertising campaign featuring famed author and sports personality George Plimpton (discussed in the next chapter). Plimpton stands outside a home on the lawn, surrounded by figures familiar from existing Intellivision advertising like a football player and boxer, but now there are new figures like a person wearing giant dollar bills (signifying finance) and even someone guiding an elephant (signifying exotic travel). Once inside Plimpton proclaims, "This new Keyboard actually transforms your Intellivision into a Home Entertainment Computer."[64] Jack LeLanne (from *Jack LaLanne's Physical Conditioning*) and Mimi (from *Conversational French*) explain that the Keyboard Component will let users take exercise classes and even a tour of France. When the commercial ends, Plimpton rises before the living room television and moves to a door, explaining that "there are a lot of new things coming to you from Intellivision."[65] Light pours in from the door's window, illuminating the Keyboard Component. The commercial links the virtual window of the television to an actual window, streaming the world inside. The Keyboard Component appears as a conduit illuminating the domestic sphere with new knowledge, services, and personal well-being through health, education, finance, and virtual travel.[66]

The commercial invited a friendly version of the computer—still a suspicious stranger—into the home. A magazine article from August 1979 effused, "Mattel Electronics is one company reaching towards the futuristic dream of every household equipped with a computer," noting that the forthcoming Keyboard Component could represent "a significant breakthrough towards tearing down the walls of fear many people have built up towards a computer-oriented society."[67] Extending gendered norms of the home, the Keyboard Component's vision of domesticating computing feminized it as well. Marketing materials portrayed women as its primary users. The manual shows a woman unpacking the keyboard, and other images show hands adorned with bracelets and fingernail polish touching various components (figure 3.5). The "Introduction to BASIC" manual depicts women using the Keyboard Component to check family finances, cook a large recipe, and ponder the meaning of $E=mc^2$. No images of male users appear until page 107.

These materials invoke female empowerment, but with limits. One Intellivision catalog shows a woman sitting next to her presumed husband as he uses the Keyboard Component to do stock analysis—an image of male control in the home. Another image shows the same mother watching husband and son play *NFL Football*. This reflects a common trope in

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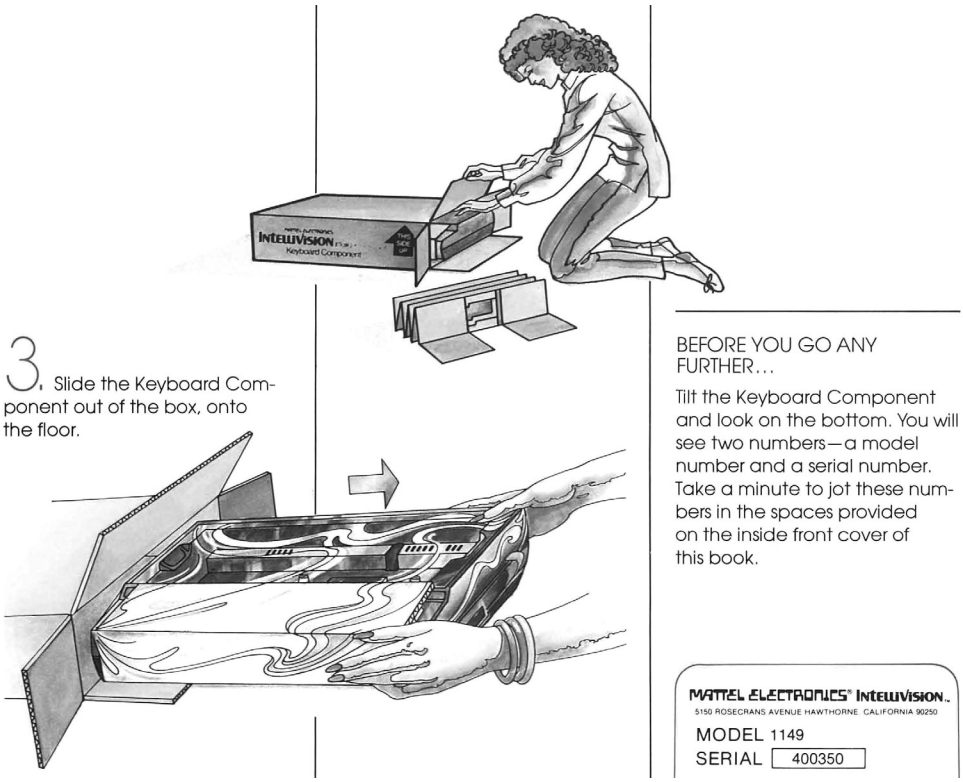

3.5 Keyboard Component owner's manual, page 4.

first-generation and second-generation advertisements, where a mother observes male family members playing videogames, gaining pleasure from domestic sociality rather than interacting with the console.[68] Another image, however, depicts a more ambiguous instance of the mother's imagined travel and use of the computer. The *Conversational French* screen before her reads "Voulez-vous aller a l'arc de triomphe? Respondez, Oui." ("Do you want to go to the Arc de Triomphe? Answer, Yes"). Her pleasure in relation to the Keyboard Component—promised by the self-improvement software before her—empowers by invoking a desire to escape from a confining domesticity. However, the virtual travel simultaneously fulfills this desire while confining her to the home.

While the Keyboard Component's marketing reflected Chandler's philosophy of home computing as self-improvement, household planning, and education, it also drew on Chang and Mattel's vision of using computing for fun and games. The Keyboard Component's manual was infused with

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ideas of leisure and play. It emphasized that the component would "domesticate itself in no time," and that users should "treat [it] like a new piano in the family. The more you play with it, the better you will understand and enjoy it." It suggested that children and adults could use Typewriter Mode to play brain games and even create art. The Keyboard Component turned the serious computer into a toy—a common marketing strategy presenting "the home computer as a useful plaything, a toy with purpose."[69] This is apparent in how the idea of play shaped the Keyboard Component's very operation. When users typed on the keyboard, goofy "bleeps and bloops" accompanied the keystrokes.[70] Reflecting Mattel's familiarity with designing toys that could not easily be broken, the manual reassured users, "Don't worry about hurting the keyboard. You can't hurt it by using it."

Intellivision's identity was initially linked closely to home computing. Tim Huber, Vice President of Marketing at the time, explained that "we never discussed Intellivision as a videogame system" in 1979 and 1980 but "always thought of it as a computer." However, by September 1980 it was unclear if marketing Intellivision as a home entertainment system with a computer add-on would be effective. The Keyboard Component was limping into test markets, and Master Component sales were sluggish. Krakauer and Rochlis—Mattel Electronics leadership—left in part due to what they saw as lukewarm support to enter the computer market, and Denham became President to turn around Intellivision sales. Mattel Electronics was at a crossroads.

While leadership was shifting in September 1980, Director of Corporate Development Mike Welch coauthored a dissent addressed to Bob Anderson, President and Chief Operating Officer of Mattel. The memorandum criticized Mattel Electronics' strategic plan to transform "from a leisure/recreation orientation into a computer division with all of the attendant characteristics of a high technology, high investment, fast moving, high risk industry."[71] Welch and his colleagues asserted that "the single most important issue" was "'should Mattel at this stage of its existence enter into the personal computer business?'"[72] Ultimately, they argued that Mattel Electronics should "not add peripherals to the current Intellivision model" and "not expend time or money on the development of a non-game personal computer."[73] That is, Mattel should abandon home computing and modular extensibility and develop Intellivision as a videogame system in line with Mattel's history as a toy company. The idea of inviting the crowded, unfamiliar, and risky business of computing within Mattel's walls spelled disaster for Welch and his colleagues. For them, it was not Mattel's business to domesticate the computer. At the highest levels of Mattel's corporate structure, leadership was debating whether to follow Chandler's vision for Intellivision

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as a steppingstone to home computing or to return to Chang's original idea for a videogame system as a more familiar extension of toys and games.

Leadership ultimately rejected the memorandum—Welch recalled that "we almost all got fired" for writing it—instead steering Mattel toward an uncertain digital future. However, the turmoil during September 1980 pushed leadership to foreground Intellivision as a videogame system before Christmas 1980, thus reflecting some of the memo's concerns. After Denham hired Frank O'Connell in October 1980 as Senior Vice President of Marketing, O'Connell conducted a study that found consumers aware of Intellivision "flat out said, 'This is a great game machine, with superior graphics and sounds compared to Atari. It is not a computer that's going to change your life.' So immediately I said, 'Look, you got to get away from promising the Keyboard.'" Leadership dropped marketing Intellivision as a home computer and marketed it as a superior videogame console compared to the Atari VCS.

However, Mattel Electronics still forged ahead with Intellivision's modular extensibility and the dyadic idea of combining the Master and Keyboard Components, despite another consumer awareness study from May 1981 finding that "Mattel/Intellivision is not associated with personal home computers."[74] In October 1981 O'Connell declared to the press that after "first seeing a boom in the video game area," Mattel Electronics "can easily work up to a home computer, because the master component leads into the keyboard."[75] Domesticating the computer remained part of Mattel's intelligent vision.

"The Keyboard Will Be Ready in the Spring"

When the comedian Jay Leno was hired to emcee Mattel Electronics' 1981 Christmas event, Dennis Marchand, Director of Recruiting, recalled how a colleague sat down with Leno to prepare. Leno then improvised an opening joke: "'The three great lies are: the check is in the mail, my other car is a Mercedes, and the Keyboard will be ready in the spring.' And the hall just exploded in laughter."[76] The joke hit a nerve because, despite numerous promises, the Keyboard Component had been delayed repeatedly and was still not released nationally.

After its test marketing in Fall 1980, the Keyboard Component was formally introduced at the January 1981 Winter CES for a February national rollout.[77] This was delayed until May, and then again in favor of a limited release in Seattle and New Orleans.[78] By November 1981, just before Leno would tell his joke, 498 Keyboard Components had been sold to retailers in the two cities, 120 of which were purchased by consumers.[79] Eventually,

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between 1,200 and 1,400 Keyboard Components were sold in these test markets.[80]

Manufacturing difficulties were a constant problem that triggered delays and led to issues with quality. In the first half of 1981, there were "struggles to develop production procedures at Technicolor," which had been selected to build the Keyboard Component in early 1980.[81] Production eventually was switched to Compro, Inc. in Costa Mesa, a city in Southern California. Dougherty recalled visiting the factory for a week "to troubleshoot why so many of the units coming off the production line weren't working. There were a myriad of little problems." These included the circuit board and connections to the Master Component, but the complicated cassette drive was an overriding concern. By February 1982, the Keyboard Component was costing $506 to $530 per unit to manufacture, and the process remained difficult and labor intensive.[82] Quality control was inadequate, contributing to a 30 percent return rate and "poor quality of finished product."[83] Another study found Keyboard Component satisfaction "substantially below Master Component satisfaction, primarily because of mechanical problems . . . and lack of software."[84]

Lack of software was an ongoing issue, especially games. Notes from a December 1981 meeting with APh staff reveal "Richard [Chang] is in a panic. He wants to iron out cassette games before CES."[85] Chang's panic reflected a worry that self-improvement cassettes predominated, and games, which could fuel sales and excitement at CES, were unavailable. But for Chang's group—in charge of Intellivision software—the Keyboard Component was not a priority. Hightower, who assisted with the Keyboard Component design and directed cassette development at APh, recalled that this was one reason it was delayed. When Mattel Electronics tried to bring cassette development in-house, they did not have the development tools that APh had designed and were hesitant to pay for them. The shortage of software titles remained even after Daglow was given responsibility over cassette development in April 1982.[86] Daglow recalled the sense of urgency, explaining that management was clamoring for cassette videogames "because when we come out of the test market, we have to have some products."

When the Keyboard Component was canceled in Summer 1982, after about three and a half years of development, Chandler blamed the Keyboard Component's troubles not on cost and manufacturing challenges but software.[87] Chandler contended that the component had been test marketed "with no available software" in 1980, that in fall 1981 there was "still almost no significant software," and that only in June 1982 had Mattel Electronics "finally organized for valid emphasis on software development."[88] But it was too late. Ironically, a lack of software—including games—contributed

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to the Keyboard Component's end. Chandler had articulated a vision of home computing based on gaming as its catalyst. Yet Chandler and Rochlis pushed self-improvement, finance, and family-oriented cassettes, not videogames, on the assumption that Master Component games would suffice. One mistake was thinking that the Keyboard Component did not need its own game software that leveraged the Keyboard Component's unique capabilities.

Indeed, the add-on was a powerful and idiosyncratic machine: copious RAM, significant cassette storage, two processors, the graphics capabilities of the Master Component chipset coupled with its own higher-resolution text—not to mention a quirky microphone. An innovative cassette like *Conversational French* tantalizingly hints at what other creative software could have emerged for the Keyboard Component, had it succeeded. For instance, one title in development at APh, "Puppet Theatre," would have allowed the creation of user-generated stories using characters built from a library of moving objects.[89] These characters, called "puppets," could be inserted within modifiable backgrounds, and the user could record narration using the Keyboard Component's microphone. This project was "a favorite of Chandler's because it was an 'activity' rather than a 'game'. . . . Tell your own story by building your own world."[90] But "Puppet Theatre," and the stories it might have told, ended prematurely.

The idea that the Keyboard Component destabilized the Master Component—making it unclear if Intellivision was a videogame console or computer—was brought into sharp relief when, in July 1982, the Keyboard Component found its way into Mattel Electronics' greatest legal threat. This was Magnavox's lawsuit regarding the patents that, in their view, meant they held the rights to technologies for object coincidence and collision on a television screen.[91] For Mattel, one key line of defense hinged on the fact that these patents covered videogame consoles. If Intellivision was the Master Component/Keyboard Component dyad, then Mattel could claim it was a non-infringing computer with uses beyond videogames. The patents would not apply. Mattel's lawyer therefore asserted that "Intellivision includes the keyboard, includes the Master Component, and all of these elements we consider to be computer-based."[92] On the witness stand, Chandler attempted to demonstrate *Conversational French* to show how Intellivision was not simply a videogame console. Magnavox's lawyer objected that "the Keyboard is not accused" and made Chandler confirm that the Keyboard Component was irrelevant to playing videogames on the Master Component.[93] Chandler foregrounded the importance of *Conversational French* but then agreed:

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CHANDLER: This helps expand, I think, the fact that [Intellivision] is a computer system and to that extent I think it is pertinent to what we are trying to present.

MAGNAVOX LAWYER: But it is not necessary to play the games?

CHANDLER: It is not necessary to play the games.[94]

In the end, the judge ruled against Mattel with wry exasperation: "What has French to do with playing baseball? One of the amazing things about baseball, you don't find many Frenchmen playing baseball."[95] The judge understood the Master Component as Intellivision's foundation—the platform was not computer-based.

The Keyboard Component was accused in another legal issue that arose during that same summer of 1982. When Intellivision was released, advertisements, brochures, and even the Master Component's packaging promised that the Keyboard Component was forthcoming. Mattel received about fifty complaints in 1980 and one hundred in 1981 regarding its unavailability. The Federal Trade Commission (FTC) became involved. A Mattel legal team led by Vice President, General Counsel Timothy Reames met with the FTC to discuss potential false advertising.[96] At issue was the "suggestion that the higher price received by Mattel [for the Master Component] may have been realized, in part, because the customer anticipated the forthcoming keyboard component."[97] Was the success of the pricey Intellivision, compared to the cheaper Atari, due in part to unfulfilled promises it could become a home computer? Likely yes, though the extent is unclear.

Regardless, customers had been misled, and as Reames explained, the FTC "makes a complaint, and you resolve it." Mattel Electronics contacted existing owners of the cancelled product, offering a refund if they returned their Keyboard Component.[98] There is a longstanding narrative that the FTC fined Mattel Electronics $10,000 a month due to the delayed Keyboard Component.[99] But as Reames noted, Mattel Electronics avoided a fine by "convincing the FTC that this was a failed attempt to market a product." Vice president of marketing Bill Gillis also recalled that "a fine was threatened but not imposed"; Denham confirmed, "I don't recall approving any payments of fines to the FTC, nor do I recall any notices from the FTC that fines would be imposed."[100]

The Keyboard Component's demise meant that Intellivision shifted back toward the initial understanding of the console as a system in the tradition of toys, fun, and games. This vision was partially realized in the Entertainment Computer System, a low-cost extension replacing the Keyboard

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Component that reframed computing around play and user modification (chapter 10). The Keyboard Component then largely disappeared from history.

The Keyboard Component's story could thus be read as a litany of failure. Expensive, convoluted, unreliable, and perpetually delayed, it was the butt of jokes and never found a viable market. When overambition collided with technological complexity and unclear consumer desires, eventually the law became involved. But as Dougherty noted, "It would have been ahead of its time if we could have made it work." Gene Kilroy, a Director in Preliminary Design who had a broad view of Mattel's research abilities, insisted that "it was ahead of its time only because a company failed to act on opportunity." Had Mattel successfully brought the Keyboard Component to market, it might have helped articulate an era of "console computing." In such an alternative platform future, videogame systems connected to televisions might have driven the PC revolution. More importantly, by redefining the Master Component's hardware to emphasize rich audio and graphical applications, the Keyboard Component was a unique machine somewhere between videogames and a personal computer. This hybrid platform, a "software player," anticipated how we use computers, smartphones, and even gaming consoles today—not only to game but to watch, not only to play but to learn and improve ourselves. Chandler, Rochlis, and Krakauer were right that the home would transform computing, and that computers would not be used just for gaming or programming but for self-improvement, education, and individual productivity. They just could not turn this intelligent vision into a successful reality.

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Mattel's Marketing Magic

4

The screen brightens to show a distinguished-looking man in a cozy living room, wearing a tan suit jacket and sitting in a wingback chair. The words "George Plimpton, Famous author and Gamesman" appear as he says, "I'll try almost anything. So when Mattel Electronics asked me to compare their Intellivision games with Atari, I gave it a try." Plimpton walks to the center of the room where there are, inexplicably, two televisions. Two kids play Intellivision *Major League Baseball* on one. The Atari version of baseball plays on the other, with clearly inferior graphics. Plimpton states, "I compared Atari baseball with Intellivision and found Intellivision played much more like real baseball. Then I compared Atari football with Intellivision. Again, Intellivision played more like the real game. In my opinion, if you try them both, there's only one conclusion you can come to: Intellivision, from Mattel Electronics." In thirty seconds, this legendary commercial transformed the videogame industry of the early 1980s and set the stage for future console wars including Nintendo and Sega as well as PlayStation and Xbox.[1]

Intellivision was always second to Atari in sales, but when it came to marketing, Mattel had no rival. If General Instrument (GI) supplied the hardware and APh the software, then Mattel conjured the marketing magic to bring Intellivision to life. In a very real sense, marketing was an enchanting technology behind the console's success. In this chapter, we chart the importance of marketing to Mattel, its toys, and Intellivision. We devote particular attention to realism, so crucial to Mattel's history and the Plimpton commercials. We also explore how male normativity—for example, the

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"Gamesman" Plimpton—shaped the marketing of Intellivision, with consequences for the history of videogames and their design at Mattel.

Some early platform studies privileged technology, but there has been increasing interest in "how social, economic, cultural, and other factors led platform designers to put together systems in particular ways."[2] Analyzing the Super NES, Dominic Arsenault implored scholars to "consider platforms not only as technological objects but also as the embodiments of marketing forces."[3] Arsenault's analysis begins with "business and marketing first, culture second, and technology last."[4] Other work, like Carl Therrien's study of NEC's PC Engine, has sought to "integrate the commercial structures" and "marketing apparatus" with an analysis of the technical platform, moving beyond "techno-industrial glorification."[5] While understanding how marketing, technology, and culture interact is crucial for analyzing all commercial platforms, Mattel's marketing magic was exceptional, fundamentally altering the history of videogames.

The Play Value of Toys and Intellivision

Mattel rose to prominence through an aggressive, all-encompassing emphasis on advertising and marketing. Scholars have underscored how "toy makers replaced the security of traditional demand with a reliance on marketing as an important criterion in production planning and product design."[6] Indeed, Richard Chang, who headed the Preliminary Design group that developed electronic toys and games, noted in his resume that he "[d]esigned and invented toys to meet a specific marketing need."[7] Marketing and product development were deeply entwined at Mattel in the 1970s and early 1980s. Marketers would forecast cultural trends and consumer desires. Preliminary Design employees would use these as broad guidelines to develop product ideas and prototypes, which market researchers would test for viability.[8] If accepted for production, prototypes would be turned over to Product Development, further refined, shaped by Visual Design, and eventually manufactured, advertised, and sold. Joan Herman, an education scholar who studied Mattel in 1976, noted that marketing "plays the most significant role in supervising and contributing to the new toy development process."[9]

At an early stage in a toy's development, Herman explained, marketing researchers would study a toy's "play value" by observing children's interactions with prototypes.[10] A child's lasting engagement with a toy was known as its play value, a term purportedly coined by Ruth and Elliot Handler "to describe the amount of involvement a child had with a toy."[11] The concept was used widely at Mattel and eventually diffused throughout the toy industry,

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since employees who migrated to other businesses "brought along systems, practices, even terminology created at Mattel."[12] One can think of play value alongside the more familiar term educational value—where, for example, toy designers and marketers claim a product teaches developmental, social, and scholastic skills. In contrast, play value identifies a child's pleasurable, imaginative, and affective engagement with toys. Play value indicates "the duration and intensity of play" and was studied by toy companies because it "served as an excellent predictor of marketability."[13]

Play value was often represented in television commercials showing children attentively engaging with toys like the Burp Gun. Indeed, by 1984 Mattel touted to investors that "network and spot advertising year-round convey the message that Mattel's products are designed to stimulate a child's creativity and imagination and provide sustained play value."[14] Mattel designers even added features to enliven a toy's presence on television. As one manager explained, when marketers were choosing what "would be featured as the most important element we often sent the Mattel R and D guys to *their* drawing boards."[15] Mattel market researchers once questioned a proposed Golden Dream Barbie because "there is no natural yellow on color television, yellow is obtained by subtracting blue from green, and the results are unreliable and often unattractive. 'You'd better be sure of what you want,'" researchers advised, "'or what you'll get is Gangrene Barbie.'"[16] Thus, television itself functioned as a technical and social platform, with its own constraints and affordances that shaped toy design.

Mattel designers and marketers had long developed features to increase play value. Early on, Elliot and Ruth used cranks on music box toys so children could interact with them continuously instead of winding them once before listening. Later, Barbie's value was associated with dress play and the prolonged interaction of dressing and undressing the dolls: "Interchangeable outfits, Ruth decided, would be the key to enhancing the doll's play value. Clothes also had the potential to be the most profitable part of the new project."[17] Play value was not only emotional but economic—extending the duration of play, building brand loyalty, and facilitating razor/razor blade sales models. Play value was a way to monetize the emotional attachments of play.

With games like Sonar Sub Hunt (1961) and Talking Football (1971), Mattel engineers had experimented with electromechanical technologies to increase play value, long before Mattel Electronics existed. Key to the design of handheld games was making little LED lights engaging. Indeed, Chang and Klose's patent for the original *Auto Race* and *Football* handhelds highlighted a "new class of games" using inexpensive, "present day electronic techniques" that "nevertheless provide a high degree of play value."[18]

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They did not simply invent a method to control LED lights with switches but a way to imbue these lights with engaging play value. In a remarkable document from 1977, the industrial designer David James pitched an idea for a preschool electronic toy after observing his "20 month old son's fascination with electronic calculators and Mattel's new Auto Race game," noting that his son's "attention span with these instruments is easily over an hour which is more than most toys for his age group can offer."[19] In language recalling contemporary mobile devices, James predicted the lasting play value would make such toys "a great babysitter while in the car, in the waiting room, at the store, waiting for dinner at a restaurant and just around the house."[20]

Play value also facilitated collaboration between marketing and design, creating a shared discourse. When Cal Calligaro was hired by Mattel Electronics in early 1979—after stints at packaged food companies—he moved his marketing group "from the corporate world down to the basement where the engineers were" because the relationship between marketers and engineers was strained. "We have to get to know them," Calligaro thought, and play value became a concept that united the groups. Calligaro recalled that "with Chang and all these other people around in market research, we started to understand very clearly . . . the idea of high play value. So, we tried to quantify what that meant through research and through qualitative and quantitative studies."

Given this context, it is unsurprising that play value fundamentally shaped Intellivision's development and marketing. In a 1982 presentation, David Chandler explained that his main task when hired in 1977 was to develop a videogame system that would "provide long lasting game play values."[21] Modern readers (and those outside the toy business) might read this phrase as "gameplay values." But audience members at the time would have recognized Chandler speaking of "play value" with regard to videogames. Intellivision was not only discussed in terms of the play value of its individual games but in terms of the system itself. "New cartridge introductions will provide ongoing game play value," read one early brochure. Thus, marketers emphasized that forthcoming cartridges would extend Intellivision's play value, recalling how Barbie's play value was linked to accessories beyond the doll. Play value was understood as additional forms of engagement, and thus individual videogames were imbued with more features, more graphics, and more things to do, while a larger library of titles increased the system's play value.

Play value provides a different way to understand videogame design in the early games industry, refracted through the influence of toys and Mattel's business to create lasting play and leisure within the home. While

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modern conceptions of gameplay address complex dynamics, mechanics, and systems of actions, gameplay in the early industry could be conceived in simpler terms—adding as many features, variations, levels, actions, and objects as possible on a cartridge with limited storage. For example, when describing videogames that have "lasting entertainment as opposed to a short lived experience," Chandler outlined the "game play capabilities" of *Major League Baseball*: how players can choose sixteen pitches, which fielders to control, where to throw the ball, whether to bunt, hit, or lead off from a base.[22] This plethora of possibility added play value and lasting entertainment to the videogame and system. Developing sports titles provided an easy method to augment play value because game dynamics were known and programmers could simulate as many elements of the real game as cartridge storage would allow.

Play value not only shaped videogames but the console's development. A robust operating system was crucial to implement Intellivision's play value. The EXEC operating system located essential game code on the Master Component, freeing cartridge memory for other features. Early on, in March 1978, Chandler worked with the idea of 2KD ROM on the system to store the EXEC, but by September Mattel Electronics requested that GI double the memory to 4KD.[23] Chandler increased the memory because APh and David Rolfe (who programmed the EXEC) demonstrated that a robust EXEC would allow the creation of complex gameplay with fewer pages of code. The additional memory would add cost to the Master Component but increase the play value of videogames. An extensive operating system would allow the system to do things like put up a title screen, easily load graphics into graphics RAM, and facilitate use of moving objects, all without using precious cartridge memory (chapter 5). From a technical perspective, the EXEC helped to solve the problem of limited cartridge space for graphics and gameplay, but from a marketing perspective it made videogames more elaborate and engaging.

While many factors affected Intellivision's development—including technical considerations, Atari and other rival consoles, and the presence of the arcades—framing Intellivision's development solely in these terms overlooks the equally important impact of toys and Mattel's influential notion of play value. This impact was facilitated by Mattel's integration of marketing within product design and development. While marketers did not always look over the shoulders of engineers to direct their decisions, their guidelines to create a system supporting engaging play shaped Intellivision's design.

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Mattel was legendary for both marketing (promoting and selling specific products) and marketing research (studying target markets and consumers). In 1990, Sydney Stern and Ted Schoenhaus wrote that "Ruth and Elliot Handler were the founding mother and father of the promotional toy business as it exists today," and Mattel was known as "the University of Toyland."[24] Derek Gable, who worked in Preliminary Design as a toy designer, emphasized, "There was no second. It was just Mattel and everybody else was learning from Mattel and copying Mattel." Marty Miller, Senior Vice President of Marketing Research and Planning for Mattel Toys, echoed this point, saying, "We were an exporter of talent" and "everybody who wanted to deal with kids or young teens took people from Mattel."

Mattel's marketing prowess dated back to its innovative work with the advertising agency Carson/Roberts, which led to the 1955 "Mickey Mouse Club" campaign. This massive, risky expenditure to advertise toys on television launched the fledgling company to the top of the toy industry (chapter 1). "Television speeded everything up," Ruth Handler was quoted as saying, adding that Mattel pioneered "retail detail" to assess if products were moving off shelves.[25] Tom Kalinske, Senior Vice-President of Marketing for Mattel Toys, and Alan Fine, Vice-President of Marketing Research, noted how Ruth hired teams of auditors in around twelve markets. These teams would visit stores and count inventory on the shelf or manage displays. The auditors would create reports with detailed, up-to-date information on "sell-through"—the relationship between how many orders were coming in and how much product remained on the shelf. Instead of waiting to hear from retailers weeks after advertisements had aired, management could quickly gain a sense of how products were selling.

Retail detail was valuable because, as Director of Corporate Development Mike Welch emphasized, the toy industry involved large numbers of new products, most with a three-year life cycle of "introduction year, peak year, close out. By year three there'd be a bin at Toys "R" Us with all the close-outs." Miller added that in this era about 70 percent of toys annually were new, compared to about 5 percent of packaged food items. Craig Spitzer, Marketing Research Manager for Intellivision, underscored the toy business's high seasonality, with 65–80 percent of sales in November and December.[26] These factors necessitated the constant, expedited collection of data to help with forecasts, determine production quotas, and suggest advertising strategies.

In the mid-1970s, as part of a "strategy to combat flagging sales of its key toy lines," Mattel hired "new managers out of the traditional packaged

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goods business who could jump-start product development and marketing."[27] Influenced by this influx of packaged goods personnel, researchers pursued longer-term tracking studies and conducted research with hundreds of participants, instead of testing products on a limited number of consumers at a mall or grocery store as Mattel had done before. Michael Katz, Marketing Manager for New Product Categories, explained that handheld games were thoroughly studied with focus groups during development: "All of that was market researched. All of that was scientifically done. That's the kind of research that those who believed in a packaged-goods-type background for Mattel's product did." While the packaged goods industry did not require the same focus on new products as did the toy industry, Katz added that packaged-goods researchers were trained in "gap analysis," looking for openings in the market for new or improved products.

While Intellivision was not a packaged good or toy in the usual sense, these marketing researchers linked their outside expertise to Mattel's existing toy marketing skills.[28] Miller noted how extensive focus group testing helped these researchers build a "contextual framework" for marketing Intellivision. This included accounting for the competition with Atari and the differing "calendarizations" of Intellivision versus its cartridges: console sales were mostly in November and December around Christmas, while cartridges could also sell year-round with a bump in February and March, when consumers tired of cartridges originally purchased with the system. Marketing researchers eventually produced over a hundred studies from 1979 to 1983 evaluating play tests, Intellivision commercials and licenses, transplatform comparisons, and the concept appeal of specific videogames. Research on hardware included general awareness and attitude studies of Intellivision as well as specific studies of hand controllers and extensions.

Mattel's excellence in marketing and marketing research was even a selling point for the console. Before Intellivision was released, a 1979 brochure for retailers proclaimed "massive advertising and promotional support," placed above a graphic of Roman columns titled "Mattel College of Knowledge." The graphic assured buyers that this novel, risky product was backed by sales support and training, sophisticated advertisements, and Mattel's long-standing tradition of marketing "scholarship."

Distinct from Mattel's marketing researchers were Mattel Electronics' marketing staff, described in one human relations brochure as "the strongest link with the consumer."[29] Marketing staff worked with the findings of market researchers, but Bill Gillis, Vice President of Marketing, emphasized that such research was understood to be "directional instead of absolute. We would certainly consider the market research reports, but judgment would have to be made as to 'what are we really going to do?'"

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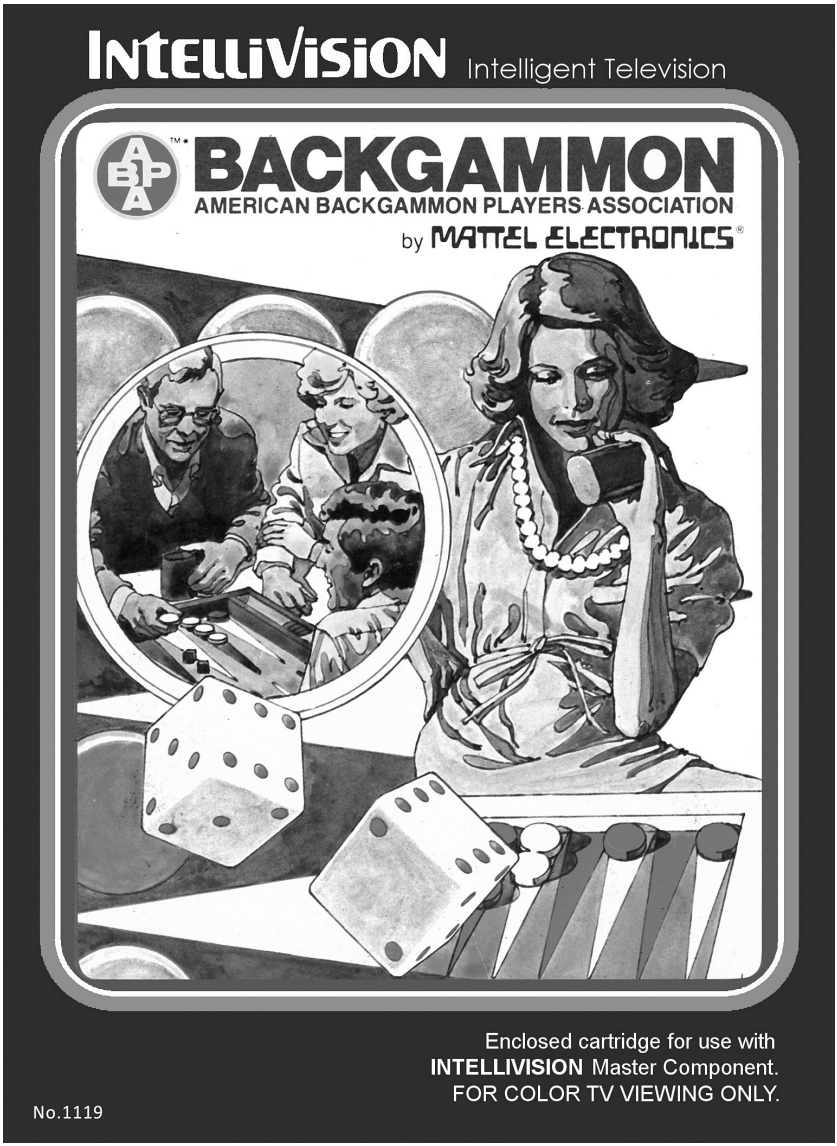

4.1 Box cover of *ABPA Backgammon*.

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Compared to marketing researchers, however, Intellivision marketers were less able to benefit from the experience with toys. One reason for this was the divisional separation of Mattel Electronics from Mattel Toys. The Marketing Director Dick Baumbusch noted, "I had no connection to anyone in the toy business. That organizational knowledge wasn't something I could benefit from." Additional challenges were the relatively small size of Intellivision's initial marketing staff, establishing new distribution channels required for electronic products, and the distinction of Intellivision as a new product category with a price point far higher than toys. Despite these challenges, Intellivision marketers shaped every aspect of the product—giving broad directives that catalyzed product ideas, working with programmers, greenlighting or canceling cartridges, editing manuals, assessing research, approving box art, interfacing with retailers, organizing promotions, and writing copy for catalogs.

For example, since Intellivision videogames were sold solely on the shelves of retail stores, packaging was crucial to Mattel's "College of Knowledge." Marketing and Visual Design staff would work ahead of time to assess the retail environment. Robert Nall, Packaging Design Manager, explained box art as "almost like a movie poster" while emphasizing that boxes created "a line identity at retail" (figure 4.1). Most Intellivision boxes were the work of Jerry "Jerr" Richardson, who had a background in advertising and was the artist behind packaging for many Mattel toys of the period, including Angel Bunny stuffed animals and Double Dooz transforming blocks.[30]

In keeping with the goal of a line identity, up to 1983 Intellivision boxes had a remarkably consistent design aesthetic, shaped by the rivalry with Atari. Arvin Carlson, Vice President of Visual Design, noted, "The first thing you would do is see what the competition is doing. We'd go out to Toys "R" Us, Walmart, see where the packaging is going to be positioned." At Atari, Cliff Spohn had pioneered a montage technique for boxes that accounted for the simple graphics of the time: partially superimposed hand-drawn images evoked the videogame without aspiring to be actual images of gameplay.[31] Richardson was clearly influenced by Spohn but developed a unique style.[32] As exemplified by *Major League Baseball* and *ABPA Backgammon*, Richardson's front covers would have "Intellivision: Intelligent Television" at the top, a primary image taking up most of the remaining area, and one or two superimposed circular images (figure 4.2). These images did not attempt to depict actual gameplay, reflecting Spohn's aesthetic. On the back cover two gameplay screenshots would appear (figure 4.3). The purpose of the front images was not fidelity but conveying the videogame's essence. Discrepancy was not deception. As Carlson noted, when selling cartridges in

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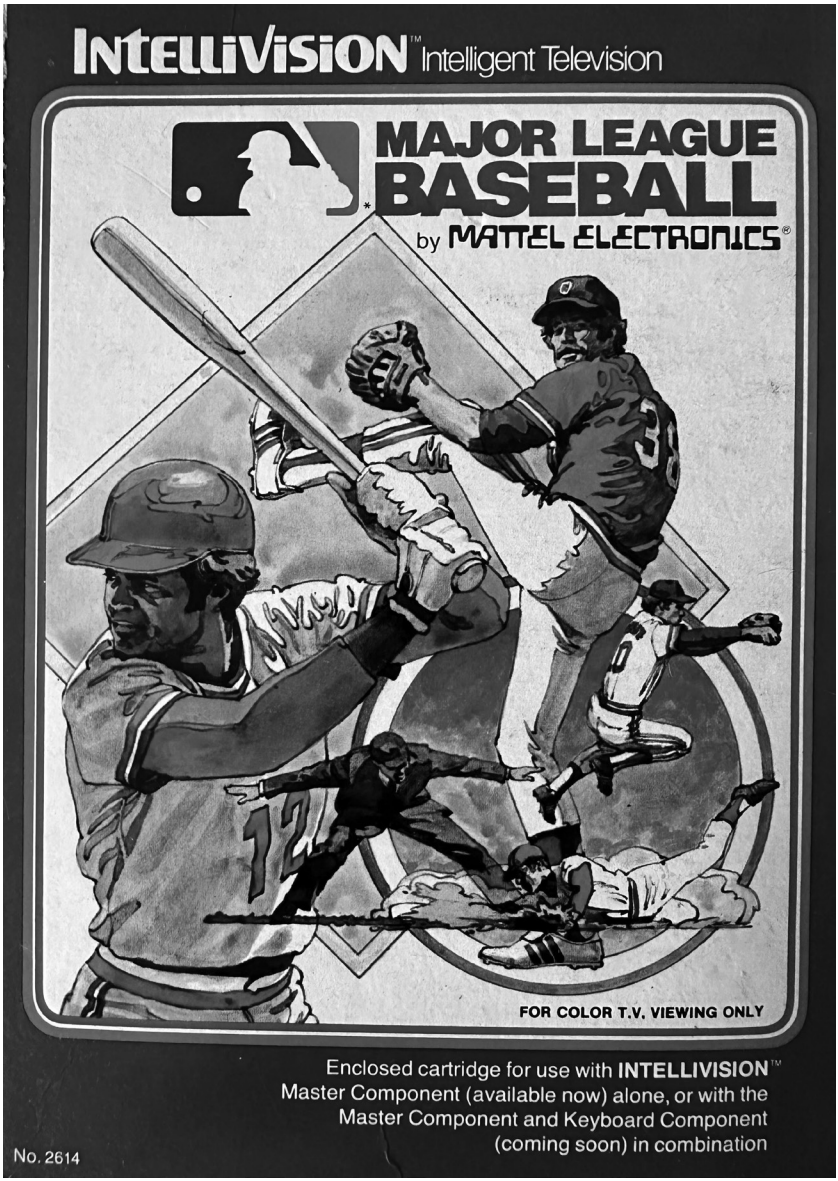

4.2 Box cover of *Major League Baseball.*

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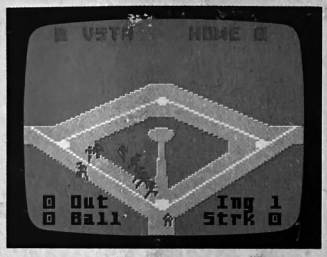
No. 2614

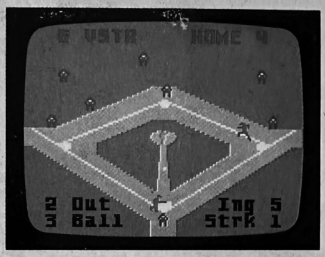
This package contains one Major League Baseball cartridge, two controller overlays, and complete playing instructions.

MAJOR LEAGUE BASEBALL cartridge

Not just baseball . . . but baseball where you control all the action! Two nine-man teams play a full nine-inning game with the strategy of real Major League Baseball! It's all there from the crack of the bat to the simulated roar of the crowd . . . and YOU control it all!



Two nine-man teams play a full nine innings of action-packed Major League Baseball! Life-like animation!



Pick your pitch! Opponent tries to outguess you! Fastball! Batter swings. It's off the right field wall . . . He streaks toward third, here's your throw. Is he safe?

- A two player game! Two nine-man teams play a full nine innings! Extra innings if needed.
- You control the pitch . . . fast balls . . . slow balls . . . curve balls . . . changes of pace!
- You control the runners and fielders . . . run around the bases . . . go for a steal . . . try a hit and run . . . throw ball to the right base.
- You do the batting . . . bunt . . . hit to the opposite field . . . out of the park home run!
- Computerized scoring shows strikes, balls, outs, innings, game score!
- Simulated sound effects such as crowd cheers, crack of the bat, Home Run!
- Developed in conjunction with Major League Baseball!

*Trademark of and licensed by Major League Baseball Promotion Corp.

INTELLIVISION™ Intelligent Television

4.3 Box back of *Major League Baseball*.

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a store with shoppers strolling down an aisle, "you had to hit the customer and tell them what the product was in that tenth of a second."

Platforming Plimpton

Intellivision was test marketed in December 1979 in Fresno, California, in about twelve department stores in the metropolitan area, including Sears, Weinstock's, and Gottschalks (a chain founded in the city). The test marketing was deemed successful, and as Mattel Electronics turned toward a wider launch in August 1980, it was clear that advertising would be crucial to Intellivision's success.[33] Tim Huber, Vice-President of Marketing during Intellivision's release, explained that Mattel's early marketing success led to a toy industry expectation that commercials would be ready for any product. Huber emphasized that if a toy was premiered at a major convention like Toy Fair without "a full, finished commercial, nobody bought it." Thus, it is unsurprising that advertising was Mattel's biggest expense after inventory. Gene Kilroy, a Director in Preliminary Design, noted it was often 15–20 percent of a product's cost, while research and development would be a fraction of that amount.

Intellivision's advertising was handled by Ogilvy & Mather (O&M). With a history dating to an agency founded in 1850 by Edmund Mather, O&M was one of the world's largest advertising companies. In December 1970 it acquired Carson/Roberts, Mattel's original advertising agency. John Seifert, who became O&M's Account Director in charge of Intellivision (and was later the company's global CEO), noted that O&M "toy category experts" often spent their whole career advertising Mattel toys, paired with Mattel's product manager for a particular toy (with whom they might be promoted in parallel). Mattel and O&M shared sales data and the impact of media spending. Many internal marketing memoranda had a left-hand column of staff broken into two groups, with Mattel employees above and O&M employees below, as if they were one company. Executives from the two companies met regularly. Gillis recalled, "Never a week passed that I didn't have a meeting or two with the O&M folks." Gene Del Vecchio, at the time a Research Project Director at O&M, noted that Mattel's business accounted for around 75 percent of O&M's Los Angeles office billings during that period, joking that "if Mattel sneezed we'd catch pneumonia." Seifert emphasized that by 1980 O&M was developing hundreds of commercials a year for Mattel across its toy lines.

O&M's first Intellivision commercial, mentioned in the previous chapter, featured the Master Component and Keyboard Component, emphasizing learning, games, and using the system for home financial planning

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and even exercise. By June 1980, marketing researchers had tested an abridged version of this spot, deeming it "ineffective in generating brand recall."[34] Intellivision sales remained sluggish throughout most of 1980.[35] Senior Vice President of Marketing Frank O'Connell recalled that this caused "a mild panic as the product was not selling at retail. The campaign essentially positioned Intellivision as a home computer," which failed to generate consumer interest.

Intellivision marketing had to adjust quickly—and it did. Josh Denham from Mattel Toys became the new President of Mattel Electronics in September 1980, hiring O'Connell soon after.[36] O'Connell recalled immediately commissioning market research which found that "unaided awareness of Intellivision is low, especially in comparison with Atari."[37] Denham and O'Connell understood it was necessary to go on the attack or Mattel corporate would "discontinue us halfway into Christmas," O'Connell said.[38] Intellivision's marketplace battle with Atari would soon turn bloody on national television.

Repositioning Intellivision would not be easy. Atari had been in stores for almost three years. Mattel Electronics Product Manager Al Nilsen noted, "We were the higher priced brand, by a lot. We didn't have the arcade history or background they did. Atari had a ton of money." Yet Atari's market position also offered an opportunity. O'Connell and the marketing department "felt a head-to-head comparison to Atari would jump our awareness and piggyback off their millions in advertising and clearly demonstrate Intellivision's point of difference."[39] Crucially, a comparison commercial only made sense because Atari had already familiarized the public with the idea of home videogame systems. O'Connell approached Mattel's board of directors with the contentious idea to spend millions on competitive advertising during the Christmas season. Atari would be livid seeing their system denigrated and their market awareness hijacked to sell a competitor's product.[40] Nevertheless, faced with huge losses if Intellivision failed, Mattel Chairman Art Spear (and Mattel's board of directors) agreed.

Because of the risk, O&M also needed convincing. Denham recalled being inspired to strike when he saw an Atari television commercial and realized Atari's "product looks like kids made it":

> I came to work and told our liaison with Ogilvy & Mather "Hey, I want you to get Ogilvy to do a comparative commercial, our product side by side. Later she said, "Well, I just talked to Ogilvy and they don't think it's a good idea to do comparative commercials." I said, "Tell them if they don't have a comparative commercial, we're going to get a new ad agency."

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The agency's reticence was understandable. Seifert noted how David Ogilvy, the advertising executive who created the modern O&M company through a merger in 1964, warned against comparative advertising because it gave visibility to one's competitor. Del Vecchio added that from O&M's perspective, a mitigating factor was that "if you're a new entrant and your product has a critical point-of-difference against the major competitor's product, it can be beneficial to make the comparison." As Denham had observed, Intellivision's gameplay and graphical realism were critical distinctions. If O&M was going to do this, Seifert realized multiple concerns had to be addressed, including the question, "Who is the person that helps you through the storytelling? Because we didn't think it was just as simple as to say 'look at Intellivision, look at Atari, you decide.'"

Thus, George Plimpton was chosen as Intellivision's spokesperson. The first editor-in-chief of *The Paris Review*, Plimpton cultivated an image of erudition but also published "participatory journalism," including books about sports. In the first, *Out of My League* (1961), Plimpton recounted pitching for a professional baseball team. Later books recounted participation in professional football, boxing, golf, and hockey. This eclectic background made Plimpton a unique fit. His intellectual air dovetailed with Intellivision's name and sophistication; his sports background harmonized with Intellivision's early emphasis on sports videogames. Seifert, who managed the ad campaign, recalled that Plimpton was "a bit of an intellect, guided by the facts, but also a good storyteller."

To convince Plimpton to participate, O'Connell remembered bypassing Plimpton's agent to call "at a hotel in Southern California, where he was playing golf." Plimpton expressed interest, and O'Connell went to Plimpton's hotel room with Brian Dougherty, an engineer working on Intellivision who recalled being asked to bring "both an Intellivision and an Atari. We set them up side by side for Plimpton to see." After playing the videogames, Plimpton agreed to do the commercials, "saying, 'Well this is great. I can participate in these sports without actually getting hurt!'"[41]

The early comparison commercials between Intellivision and Atari focused on sports videogames. It is fitting that the first commercial, described at the beginning of this chapter, used *Major League Baseball* and *NFL Football*: baseball is considered an intellectual game because of its slow pace and multiple points for decision-making, while football emphasizes strategy but also hard-hitting action. Plimpton's image, fusing intellectualism with athleticism, recalled both forms of gameplay.[42] Moreover, Plimpton's participatory journalism—pitching at Yankee Stadium and running plays as a quarterback for the Detroit Lions—buttressed his authority to decide which system was closer to the real. Gary Elliot, Vice President for

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Software Advertising at O&M, noted that Plimpton "was so believable and so completely different from what Atari was doing in the marketplace."

As sociologist Tarleton Gillespie has argued, the marketing and public relations that surround platforms join disparate ideas to articulate a malleable set of beliefs and ideologies.[43] Platforming Plimpton—giving him a stage to speak on national television—forged relationships between Intellivision's realism, sports, intelligence, action, and masculine focus. It augmented the fantasy that videogames offered the opportunity to play real sports virtually. It elevated Intellivision beyond a toy, legitimizing Intellivision's strategic videogames in comparison to Atari's childish offerings. Plimpton's persona combined minor celebrity status and the everyman, rugged sportsmanship and intellectualism, fatherly wisdom with playboy bachelorism. The fact that later research at Mattel Electronics showed that consumers had low recall of Plimpton does not indicate that Plimpton was ineffective but that his image was complex and productively diffuse—a persona that could convey multiple intersecting ideas.

Seifert, working with Nilsen and others, spent more than $8 million to produce the first series of Plimpton commercials. Accompanying these commercials were print advertisements in magazines like *Newsweek* (figure 4.4). After the Plimpton commercials aired, a marketing study found consumer intent to purchase an Intellivision increased from 5 percent in October 1980 to 28 percent in January 1981, concluding that the campaign conveyed Intellivision's "superiority to Atari and game realism themes."[44] During Christmas 1980 "we sold everything we had," Denham recalled, "our warehouse of retail was totally cleaned out. That started the whole thing rolling." A few years later Chandler summed up the Plimpton commercials' impact: "Intellivision finally was a reality in the marketplace."[45]

Closer to the Real Thing

The Plimpton campaign changed videogame history. It transformed Intellivision into a reality in the marketplace but also transformed the marketing of videogame reality. The campaign foregrounded realistic gameplay and graphics as the means to articulate differences between Intellivision and Atari. Market research registered the campaign's ongoing effectiveness, indicating that "Intellivision is perceived as being better than Atari in terms of realism of game play" and "Intellivision owners most like the realism of the games."[46] As media scholar Mark Wolf explained, the "'realism' of the games was the simplest and quickest way that consumers could compare systems, and the complexity of graphic detail and gameplay became the main areas in which home games would compete for players."[47] Although

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4.4 Intellivision print advertisement with George Plimpton. Atari *Home Run* baseball on left; Intellivision *Major League Baseball* on right.

seemingly simple, the impacts of Intellivision's marketing campaign were more complex and long-lasting.

While a detailed history of realism within videogame culture has yet to be written, an overlooked part of this history emerges from the toy industry. Mattel had long used realism to sell toys—from Chatty Cathy's "real" voice to Sonar Sub Hunt, the 1961 electromechanical game that included players looking through small plastic periscopes to locate enemy ships. Mattel marketed its realistic Burp Guns on television, including "Thunder Burp" guns in the 1960s with smoke coming out of their barrels. One commercial declared the gun "looks like real, sounds like real, it even vibrates like real . . . really for real!" This hyperbolic realism was augmented through

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commercials suturing documentary footage with children's play—hunting stampeding elephants with Burp Guns or hitting the "fire" button on Sonar Sub Hunt cutting to footage of real naval ships launching depth charges. Such blurring of fantasy with reality also appeared in Intellivision commercials, including the use of war footage for *B-17 Bomber*.

While realism was used to spur desire and give weight to imaginary play, realism could indicate economic value. "What you'd call 'realistic,' I'd call 'quality,'" said Kilroy, explaining that Mattel used realism to emphasize play value. Kilroy added, "If you look at the cap guns of the era, they were junk. When Mattel made a cap gun, it was a Rolls-Royce." When compared to Atari—retailing for $100 less and with less sophisticated graphics—Intellivision was also a Rolls-Royce. Intellivision's realism articulated quality, value, and sophistication to justify an expensive purchase.

Intellivision advertising made realism a way of seeing, comparing, and knowing videogames. In one commercial, Plimpton sits in a suit and tie with fans at a baseball game. A shot of Atari's *Home Run* is followed by stupefied fans asking, "Where's the diamond?" and "There's only four players?" Then, a clip of Intellivision's *Major League Baseball* elicits "ooohs" and "ahhhs" from the fans. At the end, Plimpton remarks "Intellivision baseball: I think it's the closest thing to the real thing." The commercial asserted not only that Intellivision videogames were more sophisticated but that realism should be the criterion for this judgment. Compared to the rowdy fans, Plimpton's sober intellectualism lent credence to the claim. In another commercial Plimpton quizzes viewers, "Here's an easy question for you. Which of these games is the closest thing to the real? A: Intellivision baseball? B: Atari baseball?" Plimpton adds "here they are again, close-up," with the commercial showing detailed shots of the running players. The close-ups are practical, but they also symbolize inspection, analysis, and getting closer to the real. The "test" format of the commercial invokes a pedagogical situation, linking realism to intelligence and learning. This approach taught consumers how to look at videogames—a new, unfamiliar product—and make judgements about quality.

Mattel Electronics marketers knew that when customers went to the store, Atari and Intellivision would be side by side, and Atari would be cheaper. Educating viewers to look for realism taught an "intelligent vision" in relation to videogames. Ultimately consumers would need to compare two things—like apples in the grocery store—and decide to pay a bit more for quality. Del Vecchio explained that Plimpton "helped convey the idea that Intellivision was the smart choice, and by extension, consumers who bought it were smarter too."[48] Thus, the "Intellivision" name was linked to the savvy consumer and intelligent television audiences who were not passive,

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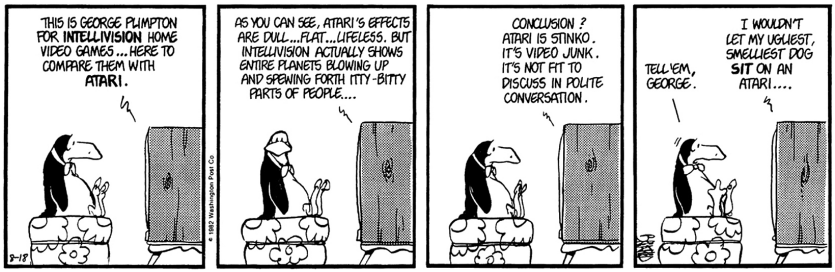

4.5 *Bloom County* cartoon (used with permission from Berkeley Breathed Productions).

mindless consumers. Leveraging discerning and sophisticated participants in consumer capitalism, the Plimpton commercials forged relationships between realism, intelligence, videogames, and technology. They created moments of comparative platform or transplatform studies. Plimpton's oft-used slogan, "Once you compare, you'll know" solidified the idea that comparison would lead to knowledge, and realism should be the foundation for this knowledge.

This advertising campaign reached a viewership far beyond Intellivision owners. The television commercials were seen by millions and covered in the *New York Times*.[49] The famed satirical cartoon *Bloom County* ran a parody in which Plimpton asserted that "Atari's effects are dull, flat, lifeless . . . Atari is video junk" (figure 4.5). Huber noted that from a marketing perspective the Plimpton campaign was "classic stimulation of primary demand. It's not secondary demand where everybody knows what it is. This is something that people didn't even know they wanted. And the only way to educate people was through advertising." For years, Mattel marketers had used television commercials to teach consumers about complicated toys—fueling the emergence of more sophisticated products—and the "Mattel College of Knowledge" followed suit with Intellivision.[50] The "ad" campaign was an "ed" campaign, oriented around realism.

The Plimpton campaign played a crucial role in training viewers how to speak the language of realism, linking Intellivision to intelligence and creating the perception that technology (in this case, videogame technology) was becoming progressively smarter, more sophisticated, real, and lifelike. This perception would be crucial for society to embrace computerization and eventually the rise of smart technologies and even artificial intelligence. Realism included gameplay, but Mattel's marketing researchers understood the centrality of graphics, explaining that "screens with detailed, realistic graphics" were important because "the industry is raising consumer expectations of graphic quality to yet another level."[51] The Plimpton campaign

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helped establish these rising expectations, inaugurating the "appreciation of realism that continues to be used today," as Del Vecchio explained. Del Vecchio went even further, emphasizing that Plimpton brought "the consumer closer to realism than had been done with Atari. Intellivision was a small but incremental step toward virtual worlds. This was a guy who needed to participate in the realism of the world in which he was investigating." Plimpton imbued videogames with reality, helping pave the way for a future of virtual worlds and society's embrace of intelligent machines.

Realism and the "Running Man"

Because videogames were new—to the world and Mattel—Intellivision's public image was blurry and undefined at first. Marketing brochures from 1979 and 1980 highlighted how challenging play and professional sports licenses added authenticity. However, the focus was on realism in terms of gameplay, not graphics. Moreover, because marketing promoted Intellivision as expandable into a home computer, early brochures featured stock analysis graphs or tax preparation questions alongside videogames. One brochure's cover showed the Master Component disappearing into the maw of the unreleased Keyboard Component surrounded by drab, empty space—as if marketers didn't know how to visually represent the overall product.

However, when the rivalry with Atari began in late 1980, the diffuse marketing of Intellivision as a home computer was replaced with a laser focus on Intellivision's detailed videogame graphics. Animated human figures were particularly important. Miller recalled viability testing that "exposed people to what looked not like little dots running around. It was people, players." One Plimpton magazine advertisement placed images of Intellivision's human sports figures next to Atari soccer player graphics, which looked like little blocky submarines. "It's obvious how much more realistic Intellivision graphics are," reads the ad, "But take a closer look. Notice the Intellivision players. They've got arms and legs like real players do." These "realistic" graphics became key to Intellivision's rivalry with Atari and were increasingly highlighted by marketers.[52] Sales pamphlets often emphasized Intellivision's "realism" in bold, highlighting the figures' appendages and how the well-proportioned bodies run realistically. All these references were to the "running man" animation, which depicted the smooth, fluid motion of a human with moving arms, legs, and head (figure 2.2).

Intellivision's capabilities facilitated the running man's recognizable details and lifelike movements. The STIC video controller separates Intellivision graphics into two layers—a background layer of playfield graphics and a foreground layer of moving objects. These two layers function

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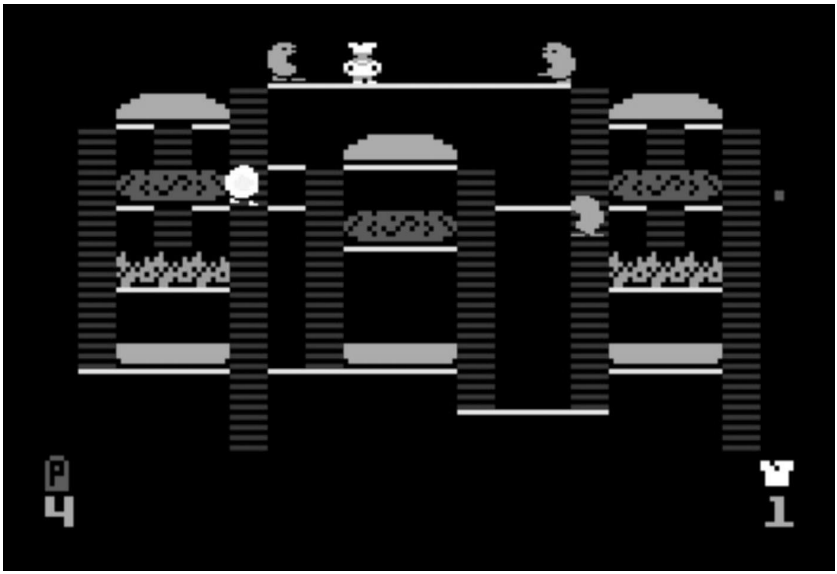

4.6 *BurgerTime* screenshot, first level.

differently, but both are constructed from the same material: 8×8 pixel tiles, called "cards" in Intellivision documents. The background playfield is created from a 20×12 grid of 240 cards, while moving objects are constructed from one or two cards.

Each card is encoded using 8 bytes of data, defining eight lines of 8 pixels each. Images on Intellivision are simple to understand since they are constructed from binary strings of 1s and 0s. This is the lingua franca of computers: high and low voltages on transistors. "1" signals an ON pixel and "0" an OFF pixel. For a background card, "1" means that the STIC displays a pixel with a defined foreground color. "0" means that the STIC will display a background color defined for each card. For a moving object card, "1" displays a defined color, but a "0" treats the pixel like a window, displaying a pixel behind the moving object, either from another moving object with a lower display priority or a background card. Consider this line of code from *BurgerTime*, which defines the ladder segment card that appears on every level in the background (figure 4.6):

```
DECLE $00,$FF,$00,$FF,$00,$FF,$00,$FF
```

The DECLE label identifies that each number is stored in a 10-bit memory location. The code is written in hexadecimal (also known as base-16 or

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"hex") notation. There are eight hex numbers (separated by commas). While the more familiar decimal notation uses digits from 0 to 9, hexadecimal notation uses sixteen digits, 0–9 and then A–F where A=10 through F=15. The first number in our example, $00, is easy to understand since it is 0. If we translate $FF from hex to decimal, we get 255 in decimal notation. Yet we need to translate the hexadecimal numbers into binary notation (1s and 0s), which is useful to mark a pixel being ON (1) or OFF (0). Again, $00 is easy since it is 0 and represented as a string of eight zeros. $FF in hex, or 255 in decimal, is equal to a string of eight 1s in binary notation.[53]

To create an Intellivision image, the magic happens when we translate the eight numbers from the line of code above into eight strings of 1s and 0s and put them into an 8×8 grid to represent the pixels. The line of original *BurgerTime* code ($00,$FF,$00,$FF,$00,$FF,$00,$FF) becomes this numbered grid (figure 4.7). To make the image easier to see, we can represent 1s (ON pixels) with black boxes (figure 4.8). The result is a series of horizontal stripes, or rungs of a ladder. If you play Intellivision's *BurgerTime*, you will see the ladders represented by horizontal blue lines suspended in black space. This is consistent with the original *BurgerTime* arcade videogame.

The *BurgerTime* ladder is a static background card used within the playfield, but cards are also used for moving objects that can be repositioned on

0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1

4.7 An Intellivision graphics card of a ladder segment in *BurgerTime* represented as binary digits.

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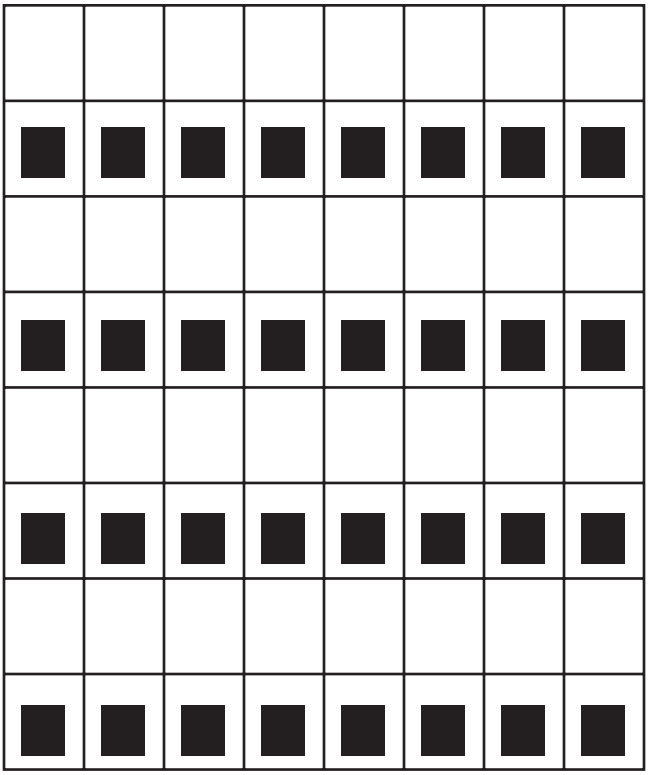

4.8 The grid with black boxes representing ON pixels.

the playfield (chapter 2). One of the powerful features of the STIC is that it can manipulate moving object cards to combine, stretch, shrink, or mirror them. For example, each frame of the running man's eight-frame animation is composed of two graphics cards, one above the other, leading to an 8×16-pixel image. In the following example, the code $0C,$0E,$00,$78,$58,$5F,$18,$00 depicts the top half of the figure and $18,$3F,$21,$62,$42,$C0,$80,$80 the bottom. Thus, the running figure with arms and legs appears—even the brim of a hat, ideal for a baseball player (figure 4.9).

You might think this would double the size of the moving object image, and indeed, *NBA Basketball* and *Tennis* used large human figures that were twice the size of a background card. Yet the STIC supports a feature to represent moving object cards at what was called "half-pixel" height, which "causes the corresponding moving object to be drawn over eight video lines instead of the normal sixteen lines."[54] Normally each pixel is drawn over two television scanlines—like the background ladder card from *BurgerTime*—but

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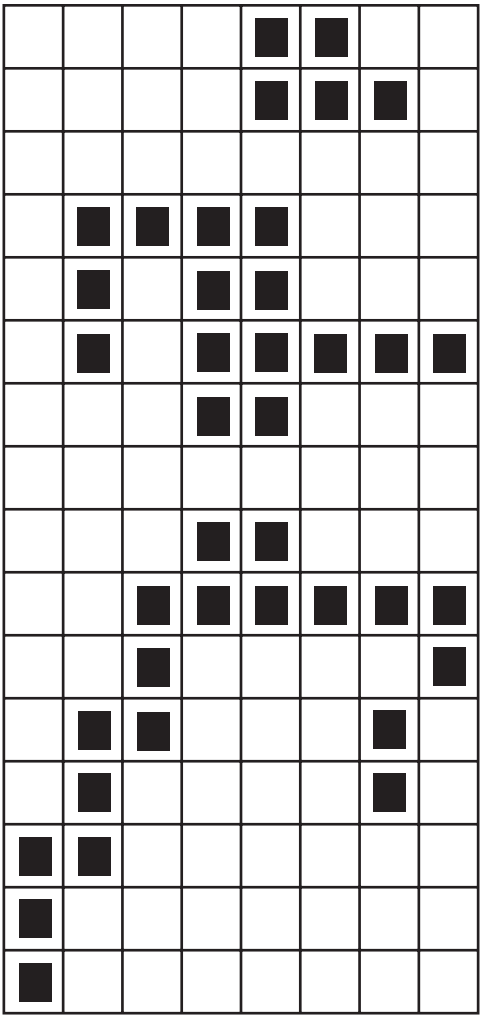

4.9 The "running man" figure composed of two 8×8 graphics cards and represented by ON and OFF pixels.

programmers can tell the STIC to vertically shrink moving object graphics cards so each pixel is half-height, drawn on one scanline instead of two. Used with one graphics card, the card retains its normal width but appears squashed, at half its normal height. Its pixels now appear like thin strips. However, as with the running man, programmers can tell the STIC to compose a single moving object from two graphics cards stored in consecutive memory locations. Coupled with the feature to shrink moving objects

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to half-height, suddenly moving objects have a much finer resolution than the background playfield. Two cards, normally with a combined resolution of 8×16 pixels, are shrunk so their pixel patterns appear in an area the same size as an 8×8 background card, producing a finer vertical resolution for moving objects. This allowed the running man to appear finely detailed.

These built-in hardware features were used for many moving objects because they could be more detailed than background graphics, which could not appear at half-height. The recognizable legs, arms, and heads so important to Intellivision's marketing and the Plimpton campaign were possible because of these STIC features. Duncan Harrower, a key GI engineer who helped design Intellivision's hardware, emphasized that Intellivision's "obvious strength was the eight moving objects and the fact you could couple [two cards] together. Instead of being 8×8 pixels, you get 8×16 pixels, which allowed the running man—and the running man revolutionized home videogames."

Intellivision's hardware influenced marketing's focus on realistic graphics and human figures. When *Bloom County* spoofed the Plimpton ads, the cartoon honed in on Intellivision's "graphic" detail (figure 4.5). Plimpton's voice emerges from a television to note, "Intellivision actually shows entire planets blowing up and spewing forth itty-bitty parts of people." These itty-bitty bits—arms and legs emerging from 1s and 0s—were produced by Intellivision's technical affordances. They became a marketing focal point to astonish consumers with "realistic" animations, and to go to war with Atari.

Marketing Masculinity

As the phrase "running man" indicates, the human of Intellivision was normatively male. In one version of the Killer Tomatoes training code, given to new programmers at Mattel Electronics, an image that illustrated how hexadecimal data translates into "on" and "off" pixels was described as "the first man picture."[55] It depicted the first frame of the "running man" animation. The "human" in this image has a raised leg and is identified as a "man," although gender markers are not prominent unless one identifies the protruding "hand" eight lines down as an apparent phallus—perhaps the first videogame dick pic. While some might say that we are seeing something in the image that is not there, the same could be said about the "running man" animation used in many Intellivision games. Since the pixel animation did not include obvious marks to suggest a gender based on cultural norms, seeing the animation as a running "man" is also seeing something that is not there—after all, we might be looking at a flamingo, not a man.

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```
;THE FIRST MAN PICTURE IS
; $0C      ———X X——
; $0E      ———X X X—
; $00      ————————
; $0C      ———X X——
; $0C      ———X X——
; $0C      ———X X——
; $0C      ———X X——
; $0E      ———X X X—
; $0C      ———X X——
; $0C      ———X X——
; $0C      ———X X——
; $3C      ——X X X X——
; $28      ——X—X———
; $28      ——X—X———
; $0C      ———X———
; $0C      ———X X——
```

Interestingly, the term "running man" was not used in marketing brochures, advertisements, or commercials, but presuming that the running figure on screen was male was shaped by institutional and cultural norms. Advertisements, videogame themes, boxes, and manuals reinforced the presumption. The "gamesman" Plimpton exuded stereotypes of male intellectualism and athleticism. Male-dominated sports monopolized Intellivision's early releases, and manuals often used masculine pronouns for both protagonists and players. Manuals and boxes from sports videogames featured images of men, though some (like *Tennis* or *PBA Bowling*) included less prominent images of women. A normative white maleness shaped Intellivision's graphic realism. As game scholar Bo Ruberg has argued, "The trouble with this constant quest for high-tech realism . . . is that it orients video games and their player cultures toward notions of the real that are themselves inherently discriminatory."[56] Graphic realism—seemingly innocuous as a goal to depict reality accurately—is intimately connected to issues surrounding race, gender, sexuality, and ability (after all, Intellivision's graphical "man" was "running").

In this chapter we have highlighted Mattel's legendary marketing, which shaped Intellivision's development and success, fundamentally altering the history of videogames and game culture's embrace of graphical realism. Yet while the relationship between videogames and gender was a recurring theme in Mattel Electronics' market research, Mattel's marketing magic fizzled when considering female players. There were few

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exceptions to Intellivision's normative maleness. For example, a "running girl" was designed, ironically, for the last cartridge completed but unreleased at Mattel Electronics, but this design did not emerge from marketing pressure.[57] One might think that the company cofounded and run by Ruth Handler—that had given the world Barbie—would have supported videogames for girls and women, if only because management understood that girls' play could generate profits. If marketing was entwined with product development, why didn't marketing insist on more videogames for girls and women?

Entrepreneur and videogame scholar Brenda Laurel, who worked for Atari and Activision, wrote that before 1990 "games for girls weren't even a twinkle in anyone's eye. Traditional marketing wisdom in the industry held that girls weren't a viable segment."[58] The history at Mattel Electronics was more nuanced because the idea to develop products for girls and women was consistently present. One of the first Intellivision studies, from the 1979 Fresno test marketing, found that a "problem is the lack of female appeal of the product," recommending "emphasis should be placed on developing more female-oriented software."[59] Gender issues were a "problem" from the beginning. Yet Mattel Electronics never truly addressed them with regard to videogame cartridges.

Part of the issue was that gendering play did not begin with videogames: toys were (and remain) highly gendered. In the years before Intellivision, "Girls' Toys" and "Boys' Toys" were distinct divisions within Mattel, with dedicated sales and marketing organizations.[60] The distinction was not always absolute: for example, in 1975 James helped explore the possibility of "Girls' Hot Wheels." This reveals Mattel's awareness of gender and their interest in marketing categories of "boys' toys" to girls but not the other way around—a common gendered dynamic where it is culturally acceptable for girls to play with boys' toys but not vice versa.[61]

A masculine norm pervaded videogames at Mattel Electronics from the outset. Gillis recalled, "We had a saying within Electronics that our customers were 14-year-old males no matter what their real chronological age." Kalinske concurred, "In those days [videogames were] seen as a boy's business." Initially it was also a man's business, with the Mattel Electronics division founded entirely by men. Early on, sports shaped the gendering of products, and Mattel Electronics explicitly marketed handhelds to boys because of sports.[62] Fine recalled testing commercials "for handheld *Football*—and it might have been *Auto Racing*—but it skewed boy mainly because of the thematics of the games." The sports emphasis carried over to Intellivision. Most early cartridges were based on sports from which women were almost entirely excluded: football, baseball, hockey, and boxing. At the

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height of Intellivision's success, one survey found the console third in popularity for women, behind Atari and the Magnavox Odyssey^2, explaining that Intellivision's "concentration on sports games accounts for the relatively light interest among women."[63]

Beyond sports, the presence of arcades also shaped perceptions of videogames and gender. Arcades were associated with boys even though women and girls "formed a significant percentage of the players."[64] However, one industry survey in 1981 "indicated that approximately 90 percent of those who play videogames in arcades are male," revealing how arcade gaming outside the home became "a socialization location for teenage males."[65] Home videogame systems like Intellivision could thus bring arcade gaming into a domestic space where women potentially could participate on more equal footing. One early-1980s study of families with home videogame systems found that 50 percent of mothers did not play, but some became proficient and overall, families played consoles together.[66] The study also noted that boys dominated over girls' play: in every family studied where the console was located in a bedroom, "it was always the boy's bedroom even though he may have been the younger of the siblings."[67]

In sharp contrast to such dispassionate studies, advertisements and magazines often drew on sexualized and misogynistic tropes of the arcades. This reflected and amplified tense equivocations regarding female agency and the access consoles potentially brought to the domestic space. Like many videogaming magazines of the time, *Vidiot* was rife with these cultural logics. An image from the inaugural issue, "The Arcade Goes Home," shows a family surrounding an Atari in a living room (figure 4.10). Only the father is playing—hypermasculinized and man-spreading on the sofa. The son, standing excluded behind the sofa, has ironically decided to go to the arcade, asking his mother for money, thus reinforcing ideas that women pay for but do not play games. Seated next to her husband, a joystick motionless in her lap, the mother is only a potential player. A daughter acts as another spectator, while a baby—lying on a pink blanket, suggesting a girl—cheers. The baby holds a lollipop like an Atari joystick, demonstrating the domestic pedagogy that might turn the baby into a future videogamer.[68]

However, because Mattel Electronics imagined itself as developing leisure products for the home, they did market products for women—just not focused on videogames. As discussed in the previous chapter, Intellivision's Keyboard Component offered gender-balanced software and was explicitly marketed to women. While dominated by sports themes marketed to male users, handhelds were marketed to women, including titles like *Computer Gin* and *Brain Baffler* (whose box images showed a man playing and woman watching) as well as *Diet Trac* for calorie counting and the

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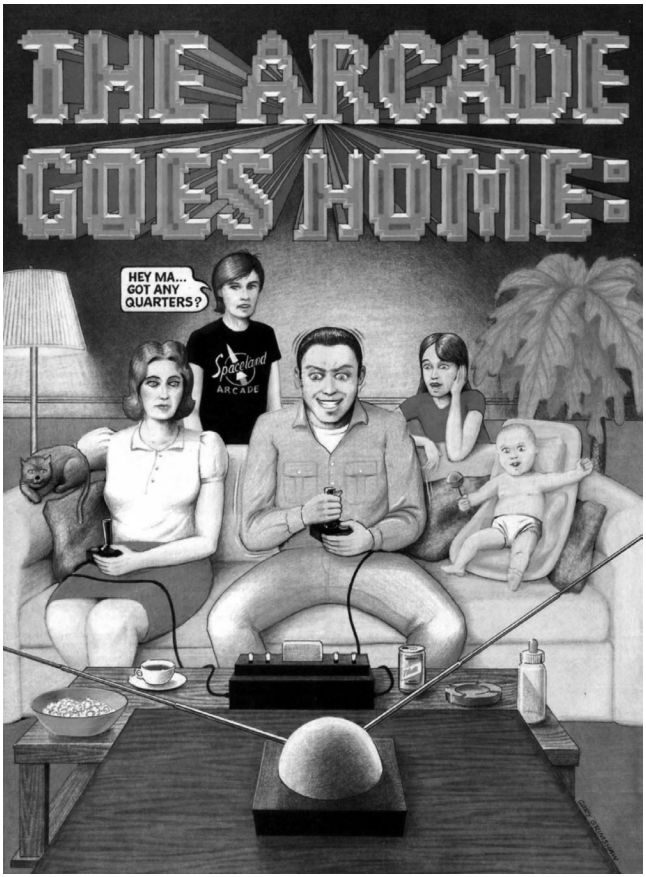

4.10 Image from *Vidiot* magazine (September/October 1982, page 44).

Horoscope Computer. While male managers were excited about *Diet Trac*, the Product Manager Kathy Austin Lockton thought women would never use it, explaining the project "flopped." Lockton felt that *Horse Race Analyzer* and *Dungeons & Dragons Computer Labyrinth* (the latter of which she played a crucial role in developing) would appeal more to women. Instead of Intellivision videogames, Mattel Electronics marketed products to female users focused on self-improvement, wellness, and traditional games. Later marketing research from Mattel reinforced this idea, suggesting in 1983 that "women have consciously refused to play video games," recommending that "minimal emphasis should be placed on developing traditional videogames for women. Instead, software developed for women should emphasize personal development, hobbies, quizes [sic], personal finance, and fantasy."[69]

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Marketing for Mattel Electronics devalued girls and women as potential videogame players. In 1983, a presentation summarizing Mattel's marketing research indicated preteen/teen boys (ages 10–17) were 40 percent of videogame "prime users," adult men were 30 percent, and women about 20 percent (with the caveat that women frequently selected and purchased cartridges).[70] Mattel Electronics identified preteen/teen boys and adult men as their primary "target market" and "adult females" as their "secondary target."[71] Another study from 1983 regarding the viability of cartoon characters for future videogames reveals women relegated to a "secondary" marketing segment and girls to a "tertiary" segment.[72] Even for cartoon characters, the key demographics remained male, and girls' preferences were pushed far to the side.

Intellivision commercials mirrored these segmentations, largely marginalizing women and girls. Plimpton entrenched Intellivision's association with masculinity, often talking with men or boys while women or girls appear in crowds or play videogames with a "brother" in the background. When the *E.T.* actor Henry Thomas was used for later Intellivision commercials, market research found that one commercial's "slow-paced, emotional execution generates outstanding recall among women," reflecting the fact that there was interest in potential female consumers.[73] Some of the Thomas commercials replaced Plimpton with Thomas's fictive younger sister, represented as ignorant about videogames. In one commercial she plays *Advanced Dungeons & Dragons*, but Thomas instructs her what to do. When she kills the difficult dragon, Thomas expresses disbelief and she apologizes, thinking she has done something wrong.

The marginalization and devaluation of female players persisted through commercials for Mattel Electronics' M Network videogames, which converted Intellivision titles to Atari (chapter 12). One commercial, "Video Blues," used Eddie Cochran's 1958 hit "Summertime Blues" with rewritten lyrics: "You dig your Atari but you're craving for new action . . . M Network is the cure for the video blues." Shots depict lackadaisical boys playing an Atari title that no longer sustains their interest, intercut with teenage girls jumping into a convertible, driving to buy M Network cartridges, kicking open the boys' front door, and jumping into the boys' arms to caress them. The final shots show a revitalized living room, the boys and girls electrified by their new M Network videogame. The "new action" delivered to the boys is hypersexualized. In one sequence, a girl's gloved and fetishized hand is shown removing an Atari cartridge and roughly slamming an M Network cartridge into the console—between her bare legs cropped in the upper left of the image. Suddenly, the commercial cuts to an image of the *Super Challenge Baseball* videogame at the moment of a hit. The message is clear: the

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boys' unsatisfied "blue balls" have been replaced by the athleticism of sports and the fantasy of a home run. The commercial associates videogame play with boys—the ones typically shown playing the cartridges—extending Mattel's tradition of segmenting "boys' toys" and "girls' toys." The girls don't just play but pay, purchasing the videogames, which aligns with Mattel's marketing to women as buyers. Yet the pleasure of the girls, also seeking action, literally drives the commercial's narrative. They are in control, even struggling for the joystick, but their boy toys are not just the videogames. They also toy with the boys, empowering their own desires.

Such commercials reveal marketers' attempt to reach out to a wider demographic, though male players remained the privileged norm. Mattel marketers were aware of growing market saturation in terms of gender. In late 1982, Spitzer wrote, "As the market saturates with games, cartridges targeted at specific segments may become a profitable marketing option. The arcades, with *Ms. Pac Man*, successfully did this to capitalize on the girl's market."[74] However, Mattel Electronics pursued limited targeting in this area. In addition to the commercials described, Gary Elliot recalled that with *BurgerTime* "we really tried to get teenage girls involved, and I know that we skewed some print ads to do that. But I don't think we did much."

Maybe Mattel Electronics would have expanded assertively into secondary and tertiary audience segments had the division not folded in early 1984—as the Toy division had done with She-Ra, an extension of the He-Man action figures. But Mattel Electronics had many chances before then, dating back to the Fresno test market. In one example, in May 1981 staff member Holly Jackson submitted a proposal for "Police Detective" and "The Great Race," explaining, "I know that you guys are brainstorming games made expressly for women in mind, and I have thought of a couple."[75] Yet nothing came of Jackson's ideas. Marketers and designers recognized that there were other potential audiences beyond men and boys. They had research to assist targeting these markets. They had videogame ideas. They always had a choice. But Mattel Electronics never made the leap.

No Barbie Girl in Mattel's Videogame World

The only released Intellivision game where one can play as female (marked by a ponytail and skirt) was *Kool-Aid Man*, a promotional title for General Mills programmed by Mark Kennedy. Yet there is a catch. The boy and girl protagonists are coupled as a single controllable entity, using the EXEC operating system's ability to link two moving objects. The kids move around a house, avoiding enemy "thirsties" while collecting ingredients to mix a pitcher of Kool-Aid. Players can switch the order of these characters, so

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either the girl or boy leads, necessary to carry more than one ingredient. When an enemy "thirstie" first touches them, the kids separate and one is always frozen. Players can then switch between them, choosing the boy or girl to control. Kennedy did not recall the inclusion of the girl being required by marketing but noted that it "seemed logical."

Female protagonists and the ability to select avatar gender are now more common but to play as female in *Kool-Aid Man* required an awkward process of detaching girl from boy. This ironically summarizes Mattel Electronics' relationship to player gender. While aware of female interest in videogames, Mattel Electronics was unable or unwilling to detach videogames from their masculine associations. This is particularly poignant given Mattel's profitable history with Barbie. No serious effort was made to develop a Barbie videogame, despite a few proposals. For example, the programmer Russell Lieblich brainstormed a Barbie game where players could "add new dresses, shoes, and even make up your electronic Barbie."[76] Stav Prodromou, Senior Vice President for Operations, noted that gender stereotypes played a role: "Barbie was never a subject because Intellivision was for teenage boys." Moreover, the Mattel Toys division was motivated to protect the Barbie brand. When programmers were once invited to propose an idea "utilizing Barbie and Ken," they were warned that "it may be an impossible task of diplomacy," indicating that tensions between Mattel Electronics and Mattel Toys contributed to the lack of a Barbie title and isolated the former from the latter's expertise in girls' play.[77]

Despite the entrenched focus on the male demographic, some Intellivision titles did have female players in mind. For example, in the one-player *Royal Dealer* (which included card games like Gin Rummy, Crazy Eights, and Hearts), all three computer opponents sitting around the table are women, implying that the fourth, human player might also be female (figure 4.11). The videogame was understood by APh programmers as offering "the most popular card games used for relaxation and boredom-alleviation . . . targeted at the soap-opera set."[78] Mattel Electronics chose to produce it as a "minor release."[79] Drawing on the stereotype of the bored housewife, *Royal Dealer* repurposed traditional card games for an imagined female domestic consumer without exploring more innovative possibilities, implicitly suggesting that women players were uninterested in action, exploration, or fantasy.

Frog Bog—where players control jumping frogs on lily pads and eat insects to collect points—was also designed at APh with a different audience in mind. Its programmer, Tom Loughry, wrote that it was "a nice simple cartridge for young children & specifically girls. Low pressure, nice graphics, no strategy, simple controls."[80] Anticipating the contemporary divide between complex hardcore videogames (often masculinized) and simpler

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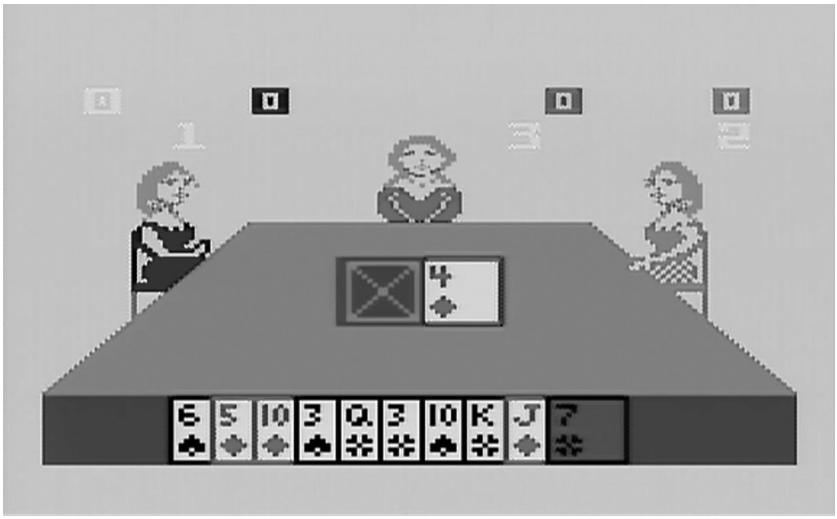

4.11 *Royal Dealer* screenshot.

casual videogames (often feminized), *Frog Bog* contrasted with Intellivision's typical high-strategy offerings. Girls were seen as outside the norm, such that a title that reverses the norm (less complexity, less strategy, less pressure) would cater to them, an approach critiqued by feminist videogame scholars.[81] In theory, programmers could have drawn on Mattel's longstanding expertise in gendered play, though Spitzer explained, most programmers "were 25-year-old guys who thought what was fun for them was fun for everybody. They didn't understand girl play patterns."

As noted earlier, Intellivision marketers were isolated from the Toy division. However, Mattel Electronics did research female videogame players, just not extensively. In a late 1982 summary, Spitzer noted that "The preceding discussion has implicitly treated the marketplace as a single, homogenous mass. It is not. There are differences that we know about boys' and girls' preferences."[82] Spitzer explained, "Girls prefer games which are 1) less aggressive in theme 2) slower, 3) less complex, and 4) less strategy-oriented."[83] Such studies must be taken with a grain of salt. Assumptions that women prefer less aggression, complexity, and strategy are tainted by gender stereotypes. Nevertheless, marketing researchers understood the need to study gendered play patterns and develop different videogames for distinct audiences.

In April 1983, less than a year before Mattel Electronics folded, marketing requested new game ideas for female audiences. Intellivision programmer and manager Don Daglow explained in a memo that "Marketing

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Research isn't sure what kinds of games those should be, except that shooting things, blowing things up, etc. are definite turnoffs for many women."[84] These general directives reveal a lack of research and understanding but also a desire to reach this market. Daglow added, "Women are the biggest untapped market for video games, but thus far most companies have only talked about trying to reach them instead of designing cartridges for them. Our group, I think, has the necessary skills to change that pattern."[85] At this precise moment, programmers were reviewing potential arcade licenses from Stern Electronics Inc., suggesting the arcade game *Anteater* might have "cross-sexual appeal (which is not to say that it's sexy)" and recommending they "test the game on women."[86]

Some female programmers pitched ideas beyond established genres to reach female players. Karen Nugent recalled suggesting a "Shower to Shower" videogame that would involve household labor, foreshadowing contemporary time management videogames often marketed to women. Players taking a shower would be interrupted by a ringing phone or dog barking, but leaving the shower would cause "mold monsters" to start "coming out of the drain, so you have to go back and shake Comet on it." In another example, Connie Goldman proposed "Kiss the Frog," with a princess attempting to turn frogs into princes: "Frogs, being the not-too-bright creatures that they are, will try to hop away from the princess. And, of course, princes, being not much brighter than frogs, can and do get themselves turned back into frogs."[87] Goldman recalled being "fascinated by old medieval stories, and I thought, 'I can't be the only girl fascinated by these stories.'"

Another proposal from Goldman, "Quest," also built on medieval and gendered themes, eventually becoming *Thunder Castle* (designed with Dave Warhol). Goldman envisioned a knight saving a princess from a dragon's lair, which "might get more girls interested." In the proposal, after the knight saved the princess, the two would escape, besieged by enemies trying to separate them—a twist on the typical damsel-in-distress narrative. If the princess was recaptured, Goldman wrote, "our poor tired knight will have to win her all over again."[88] This is not an image of heroism in the face of challenge but snarky sympathy for the knight's plight. Goldman's interest in potentially reaching more female players was marked by innovative ideas that simultaneously poked fun at masculinity while channeling traditional forms of gendered desire.

The released version of *Thunder Castle* lacks these gendered dynamics, testifying to the difficulty in bringing alternatives to a male-dominated market. The knight kills dragons, evil wizards, and devils without a princess, though a rescue narrative is suggested by level themes that progress from outside to within castle walls, eventually reaching a dungeon. Sometimes

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a comb appears, to be avoided since touching it cuts one's score in half. Warhol explained it was added as a symbol of "vanity," one often associated with femininity.[89] The oddity of this item makes it stick out like a cowlick. In a videogame where gendered dynamics are submerged (despite its original conception), a symbolic element associated with femininity becomes an obstacle to male mastery, casting the feminine as harmful.

Whiteness was normalized alongside heterosexual masculinity. Race, like gender, was difficult to represent graphically on Intellivision. However, it could be implied, for instance, by team sports that were racially diverse. *World Series Major League Baseball* was originally designed to feature actual professional baseball players. Eddie Dombrower designed the graphics so that the players were Black or white depending on who they represented. For this reason, it may have been one of the first racially diverse videogames.[90] However, when for legal reasons player last names were changed to those of Mattel employees, at least one programmer asked Dombrower to change the graphics, "not wanting to be Black in the game."[91] Most advertising (including the Plimpton commercials) featured only white actors, but there was Black representation in some print advertisements, and one marketing study found growing interest in purchasing an Intellivision among Black consumers.[92] Yet race was not a typical category for Intellivision market research nor a typical discussion point for videogame design.

Box art portrayed the presumed desire of the consumer as fundamentally one of whiteness (see figures 4.1 and 4.2). Cover images showed white women, men, and children at play and sport: the smiling winners of *Las Vegas Poker & Blackjack*, the laughing father and son of *Checkers*, and the gaming family of *ABPA Backgammon* depicted white families or heterosexual couples. The heroes of *Advanced Dungeons & Dragons*, *Night Stalker*, and *Lock 'n' Chase*, the military commanders of *Sea Battle* and *Armor Battle* appear as white men on box covers. Even sports titles privileged whiteness, with the majority of covers depicting white, male athletes. In cases like *NBA Basketball* and *NFL Football* where Black athletes appear, white athletes are more prominent and often literally encircled and emphasized.

Nevertheless, racial analysis of early videogames remains crucial. For instance, when designing *Kool-Aid Man*, Kennedy explained choosing yellow for the boy and white for the girl because of his Chinese wife. Had the colors been switched, Kennedy feared racially charged joking that the characters were based on his actual relationship. This small detail demonstrates racial stereotypes influencing design. The contemporary period in gaming culture is marked by an acute awareness of inequality, sexism, and racism in the videogame industry. It is vital to understand their histories, even when documentation is incomplete.

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For example, sexualized humor sometimes circulated within Applications Software, the Intellivision game programming group within Mattel Electronics (chapter 6). When designing *Tron Solar Sailer*, a title for the Intellivoice extension (chapter 9), Robinson and Gene Smith noted that the digitized word "can't" sounded like "cunt." When written memos failed to convince management of the problem, a parody videogame based on *Astrosmash* was created, "Space Cunt," with the enemies changed to "cunt," "the pill," "I.U.D.," and "spermicide."[93] In 2014, a fansite published the unreleased title. A more misogynistic parody took the form of a proposed videogame "Swallow It, Bitch!," in which a cheerleader would perform oral sex on members of a basketball team.[94]

However, Intellivision games from Mattel Electronics and APh typically were absent of blatant gendering. Knowing that female teens played in the arcades, studying arcade games was one of the rare cases where Mattel Electronics examined female videogame play preferences. Their focus groups found that "males seem to prefer faster paced, more aggressive games than females," recommending both "segmenting videogame players on abovementioned factors" and studying gendered videogame preferences to see "if they pertain to home video games."[95] Part of the issue stemmed from Mattel's research finding that teenage girls were put off by arcades and were uncomfortable playing in public. With conversions and original offerings like *BurgerTime* and *Thin Ice*, Mattel Electronics hoped to reach some female players. Data East's *Disco No. 1* featured a roller-skating man surrounding women dancers to enclose them and gain points. Gabriel Baum, Vice President of Applications Software, insisted on removing sexist themes from the arcade conversion that became *Thin Ice*. As converted by Julie Hoshizaki, the game involves a penguin surrounding and dunking other penguins.[96]

Videogames from Mattel Electronics and APh also eschewed adolescent damsel-in-distress narratives embraced by several third-party developers, including Parker Brothers' *Popeye* as well as Imagic's *Beauty and the Beast* and *Tropical Trouble*. In *Popeye*, players must collect letters falling from a captured Olive Oyl that spell H-E-L-P, while in *Tropical Trouble*, a side-scrolling game, players save a kidnapped woman being carried away and depicted by a pair of flailing legs on the far right of the screen (figure 4.12). *Tropical Trouble* depicts gendered violence for childish laughs while also symbolically suggesting that women are only included in videogame space halfway—half inside as a sexualized, fetishized reward and half outside as an unrepresented demographic. In the end, decles didn't last, Intellivision didn't last, even Mattel Electronics didn't last—but gender inequality in the videogame industry did. Mattel Electronics occupies a key place in this checkered history of both exclusion and inclusion.

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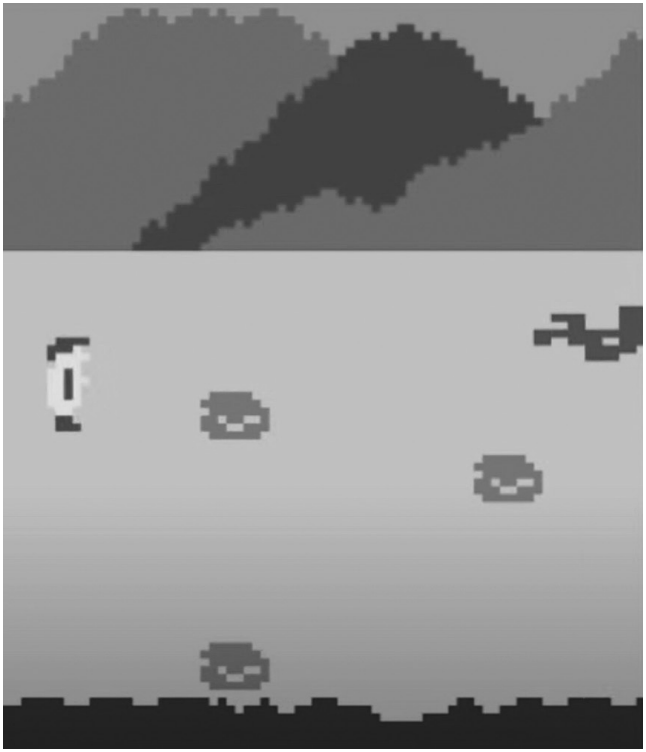

4.12 Detail from *Tropical Trouble* gameplay.

Mattel's marketing magic was at the heart of Intellivision, just as much as chips and code. Intellivision appeared in a fluid moment when videogames were a nascent form of entertainment. This created both continuity and discontinuity. Mattel's marketers embraced the familiar—play value, realism, television, and gendered toys—to understand and develop the unfamiliar category of videogames. As a result, Mattel's marketing shaped the history of videogames. This included a momentous impact on the future of videogames oriented toward graphical realism, and of console wars intent on rivalry. However, the separation of Mattel Electronics from Mattel Toys also created discontinuity and missed opportunities, where Mattel's marketing and design could have drawn more forcibly on its institutional history to explore the diversity of videogame play. This shortsightedness also influenced the future of videogames as the industry remained dominated by hegemonic masculinity. Through both its success and failure, Mattel's marketing reveals how economy, culture, and the history of toys are foundational to platforms and to platform studies.

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Practices

II

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Ladders of Game Production

5

Intellivision was shaped by Mattel's history with toys, its hardware, and the magic of Mattel's marketing. Yet everyday practices of design and development that formed around technological structures were just as important. A body of scholarship has explored the "embeddedness of design practice" with regard to videogames and other software.[1] Developing games in the early 1980s, however, was not a question of individuals doing an established, familiar job. Programmers and engineers were developing the code, systems, tools, and social practices to scaffold production and design—practices we explore in this second part of the book. This meant coding software and writing documentation. It meant forging tools and forms of collaboration. It meant developing new ways of learning, planning, and cultivating creativity. The Mattel programmer David Stifel summed it up by saying, "We were inventing the games industry."

Stifel's major project, "Game Factory," was developed for Intellivision's Entertainment Computer System (chapter 10) and completed days before Mattel Electronics closed its doors in early 1984. The draft manual of this unique, unreleased title noted that users began with a menu "just like the main directory you find on the ground floor of any office building." They would then pass through "departments" like "moving objects" and "game screen." As they progressed through the factory, users would learn to create their own games. In short, "Game Factory" would let users play around with game design, recalling the experience of Mattel Electronics programmers themselves.

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"Game Factory" was the culmination of Stifel's own journey. Stifel came to Mattel Electronics with an MFA in acting. He learned about computers while teaching English in Egypt before enrolling in a six-month information technology course at a trade school back in the United States. He recalled how Mattel Electronics at the time was "hiring people with all kinds of odd backgrounds." Stifel learned the ropes by designing a demo cartridge composed of previously released Intellivision games. Later, he helped revise "Your Friend, The EXEC," the manual for Intellivision's operating system, collecting material from programmers to document their tricks and techniques. Stifel was learning and chronicling emergent infrastructures of videogame design. As anthropologist Susan Leigh Star explained, such infrastructures are "sunk into and inside of other structures, social arrangements, and technologies" while being learned and taught through "conventions of practice."[2] At Mattel, these conventions emerged from a long history of treating labor as play and play as labor—a fact hinted at in the title of Stifel's "Game Factory."

David Rolfe, the APh employee who programmed Intellivision's EXEC operating system and wrote the original "Your Friend, The EXEC," echoed Stifel's experience: "I took the STIC [Intellivision's graphics chip] and added the EXEC, and this created a platform which the individual cartridge designers would carry to an even higher level. So we were all just taking what we were given and carrying it another rung up the ladder."[3] Rolfe envisioned the Intellivision platform as a ladder with "rungs" of hardware, software, and development practices. Given Intellivision's hardware, Rolfe built a rung of software, the EXEC, so programmers could ascend further. Given the EXEC, Stifel created a cartridge for making games. Both added a rung to the Intellivision platform, transforming it into a dynamic, historically evolving system—what we term a "platform culture."

A platform culture is a historically situated assemblage of technologies and social structures, persons and players, conventions of practices and transgressions of those practices. Rolfe spoke of carrying something up a ladder, but ladders can also be used to go down or stop somewhere in the middle, as when painting a house. Moreover, ladders are not only technical but social tools, which someone might hold to steady for another. Indeed, Rolfe explained that programmers worked individually but "had help. We had the art, the hardware. There was a support system."

Thinking about platforms as ladders and support systems highlights how platform cultures operate as cumulative, collaborative practices. It highlights how a platform is not a singular surface on which one's work is elevated but a multiplicity of rungs supporting different forms of

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engagement and levels of expertise. Moreover, thinking about platforms as support systems allows us to understand not only how platforms support creative expression and shape videogame aesthetics but also how they provide practical assistance, ease the burden of programming and design, and create an accessible framework for communication. In this chapter, we explore key rungs in Intellivision's platform and ladder of design. These rungs, and the technosocial practices that surrounded them, profoundly shaped the emergence of Intellivision's platform culture.

Riding the Beam

Rolfe explicitly identified the STIC (Standard Television Interface Chip) when mentioning the rung that supported his work on the EXEC. As explained in chapter 2, the STIC synchronizes with the electron beam of the cathode-ray tube (CRT) television to modify the display, defines Intellivision's background graphics, and provides programmers with versatile ways to control its eight moving objects—including size, location, color, and so on. By building such control into hardware, the STIC significantly eased programmer labor and shaped design practices. However, the STIC was even more fundamental in terms of affecting programmer practices because it automated displaying the television image.

This automation fundamentally distinguishes Intellivision from Atari: "Programming the Atari VCS means drawing every line of the television display individually, making decisions about how to change the display on a line-by-line basis rather than setting up a screenful of pixels all at once."[4] Atari programmers must "race the beam," staying one step ahead of the electron beam while the CPU executes instructions to assist drawing the screen. This requires precise programming techniques and timing, like counting CPU cycles for each instruction, because there is little room for error. When the electron gun finishes painting the frame and begins its vertical retrace for the next frame, Atari programmers must compute game logic and changes for the next frame. As someone who programmed both Atari and Intellivision games, Rolfe explained that with Atari, "the CPU could do nothing during the screen painting except create that image on the fly, line by line. And then it had that briefer interval during vertical flyback, during which it had to do all the computations for the upcoming frame. This was gruesome."[5] In contrast, for Intellivision, the STIC's parameters and other information are updated during vertical retrace, and then the STIC takes over when active display time begins. Unlike Atari, this frees CPU cycles to process game code instead of being used to tell the graphics

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chip how to draw the current image. While not unique to Intellivision, this automation was a significant development within videogame history and a sought-after goal for engineers within the industry.

By automating the display, the STIC reduced programmer labor. "As Intellivision programmers," Mattel Electronics programmer Bob Newstadt explained, "we didn't count cycles. On the Atari they had to. That was a big difference. We could focus more on the gameplay because we had the STIC."[6] As Newstadt described it, "the hardware was riding the beam." As long as programmers updated information supplied to the STIC between frames—like the location of moving objects—the STIC would do the rest. Moreover, programmers did not have to worry about writing code to feed information to the STIC if they used Intellivision's EXEC operating system: one of the primary functions of the EXEC was to handle communication with the STIC during vertical retrace. In fact, this was just one of many friendly services that Intellivision's "operating system" provided.

Your Friend, the EXEC

You might think that when you power up a Master Component, its CPU executes code from the plugged-in cartridge. But cartridge code is not the first thing the CPU reads, nor does the cartridge contain the main program running in the background for most Intellivision games. Instead, this main program is the EXEC or "executive program"—about 4.25KD of code stored on all Master Components.[7] In their classic study of technosocial practice, Star and Griesemer defined "boundary objects" as inhabiting "several intersecting social worlds . . . plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites."[8] For Intellivision game design, the EXEC was a boundary object with no equivalent on systems like the Atari VCS—a rung of software above the hardware, a support system, a set of technosocial practices, and a shared language of game design.

The EXEC became known as the first operating system developed for a videogame console.[9] In many ways, it functions as an operating system—for example, by managing interaction between videogame code on cartridges and the STIC chip that displays graphics on a television. Yet APh's Glenn Hightower dismissed the idea, flatly stating that "the EXEC is not an operating system. It is nowhere near an operating system. It's an operating system like a bat is a bird." The EXEC does not approach the complexity of resource management, multitasking, and hardware control associated with a modern OS, although it does some essential work of an OS, like constituting "a buffer" between software and hardware and creating a framework "for

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the user to work with the computer."[10] However, unlike a generalized OS for a personal computer, the EXEC also has an intimate connection to gaming. This was reflected in "Your Friend, The EXEC" when Rolfe called the EXEC both an "operating system" and "the game controller" program.[11]

One reason to hestitate calling the EXEC an OS would be that its original purpose was to extend the value of a 4KD cartridge. In effect, the EXEC added 4KD of code and useful programs for games onboard the Master Component, significantly expanding the sophistication of Intellivision games. In "Your Friend, The EXEC" Rolfe emphasized precisely this point, noting the EXEC "was originally written to save code in cartridges," which could be used for more gameplay and graphics.[12] Rolfe explained, "An Atari VCS cartridge contained the entire program for an Atari VCS game. With Intellivision, we wanted to get more mileage out of our cartridges, preferably without making them 8K ROMs."

But what should go into the EXEC? "The EXEC was the generic code" for the system, Rolfe said. Hightower assigned Rolfe to write the EXEC along with two games, *Major League Baseball* and *Las Vegas Poker & Blackjack*. "The job I gave Rolfe was to take the two programs and split them," Hightower explained, "putting the code the programs had in common into the Master Component ROM and the game-specific code into the cartridges." Deciding what to put in the EXEC was important, since it would be burned into every Master Component. "You get one pass to get the EXEC right and then it is frozen," Rolfe explained. There was also "a big chicken-and-egg issue," Rolfe recalled: "Once you create a feature in the operating system, do you need it? You want to have a game to test the operating system."[13] Fortunately, *Major League Baseball* and *Las Vegas Poker & Blackjack* were radically different. If the EXEC contained code useful for both, it would likely be useful for future games. For example, both games use EXEC routines for initializing and killing moving objects (INITOBJ, KILOBJ) and even the EXEC's "Trail Module," which contains routines for object movement (like ONTRAIL, which will move an object across the screen given a destination point and speed). This was helpful in *Major League Baseball* for sending computer players from base to base, and for *Las Vegas Poker & Blackjack* to move the dealer's tossed cards down the screen.

Indeed, creating the EXEC was a social process. Other programmers at APh were working on Intellivision's first games alongside Rolfe, suggesting and testing features, even becoming dependent on early EXEC code, which then began to lock in certain features. APh programmer Tom Loughry emphasized that the EXEC's routines "were extraordinarily useful, especially initially." It handled sound, title pages, controller input, updating Intellivision's graphics chip: "All that stuff was useful for everyone," Loughry said.

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It also contained a library of code, including routines for basic math, printing alphanumerics on screen, and clearing RAM, though Loughry noted he never used the "Trail Modules," preferring to write specialized code for object movement that was contained on the game cartridge.

But the EXEC could not include everything. "It rapidly gets to the point where if something has to go in, something has to come out," Rolfe said. For example, scrolling assistance was not included, even though APh programmers wrote scrolling code that was available and discussed in "Your Friend, The EXEC." Thus, every game that used scrolling had to make room for this code in its cartridge ROM—a tricky task, especially for early 4KD games. Laughing, Rolfe explained that "probably the reason for that was *Baseball* did not do that kind of scrolling. In some sense, the EXEC was written to support *Baseball*." In hindsight, scrolling would have been perfect to include in the EXEC—but in the late 1970s, with single-screen games populating the arcades, scrolling's future ubiquity was unclear. Moreover, it would take up precious space in the limited EXEC.

The EXEC evolved into more than a space-saving device, and game programs on cartridges became deeply entwined with it. "Strictly speaking, the EXEC is like a body without a soul," Rolfe said. In this metaphor, the cartridge is the soul bringing the EXEC to life, while the EXEC is the body of processes that carry out the soul's desires. This dance between the EXEC and cartridge code is clear when swinging one's bat in *Major League Baseball*. The EXEC handles much of the work, first by calling the BATSWING routine contained on the cartridge ROM:

```
BATSWING::BEGIN
    CMP     .UP,R1          ;IS THIS COMMAND FROM UP PLAYER?
    BNZ     RETINS          ;IGNORE IT IF NOT
    MOV     #NOKEYDSP,R0    ;PREVENT FURTHER SWINGING
    MOV     R0,.KEYDSP      ;BY NOT LISTENING TO KEYPAD ANYMORE
    CALL    S.SWING         ;BAT SWING SOUND
    MOV     .BATRUP,R0      ;GET OBJECT NUMBER OF BATTER
    CALL    TOOBJ           ;GET DATA BASE
    ADD     #.OBJSEQ,R1     ;WANT TO START SEQUENCING
```

This is assembly language code from the *Major League Baseball* cartridge, with CPU instructions on the left. The text after the semicolons are nonexecutable comments left by Rolfe to describe what the code is doing. Since this is a two-player game, the BATSWING routine checks to see if the button press came from the player at bat, branching away from the routine if not (BNZ means "branch away if the result of the compare, CMP, is not zero").

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The code changes the EXEC's .KEYDSP variable (the key dispatch) to switch off the keypress interaction on the hand controllers. This prevents you from swinging twice. Then the code triggers the bat swing sound, a process that also uses the EXEC. BATSWING uses another EXEC routine called TOOBJ to retrieve the moving object of the batter and manipulate its animation sequence (using .OBJSEQ, another variable used by the EXEC). This starts the batter's swinging animation, which is also handled by the EXEC. Then, if the videogame code on the cartridge determines that you hit the ball, the EXEC handles its movement. The EXEC code and the videogame cartridge code are thus constantly throwing control back and forth, like two kids playing catch.

The EXEC thereby provided a framework that handled many essential functions of Intellivision programming. For instance, the STIC chip could put a moving object at different screen locations but not move it gradually from point A to B. Another example is that Intellivision's graphics system had the potential to animate graphics, but the hardware did not do this automatically. Yet another example is that the STIC recorded overlaps and "interactions" between moving objects, but programs needed to retrieve, update, and use this information. These were obvious elements that the EXEC could implement; otherwise, a cartridge would need to take up precious memory to do so. Programming *Major League Baseball* simultaneously with the EXEC facilitated this implementation. Rolfe explained that baseball was "a nice generic game. It had characters moving. It had interactions. It had the bat swinging." Thus, the EXEC implemented key elements like object movement, interaction, and animation.

Of the EXEC's many functions, the most basic is handling low-level interactions with the hardware. APh programmer Hal Finney explained that the EXEC "was in all the units and hid a lot of the gory details."[14] The goriest details concern servicing hardware interrupts and updating the STIC registers and graphics to change the display. For example, sixty times a second, the STIC broadcasts an interrupt signal when it completes drawing a single frame of the television image. When the CPU receives this signal, it gains access to the STIC registers and the graphics area for an extremely limited amount of time. At this moment, the EXEC writes information to the STIC to adjust its memory registers (like changing moving object locations), fetch object interactions that the STIC records, or change moving object graphics cards to produce animations. Servicing interrupts efficiently and without errors is paramount to the operation of a videogame—thus, it was a key service operated by the EXEC.

As described in "Your Friend, The EXEC," the EXEC's "most important function" was handling Intellivision's eight moving objects, the bread

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and butter of videogaming.[15] The EXEC provided a software wrapper around these objects—defined by the technical affordances of the STIC—thus allowing programmers to easily control their powers. If programmers wanted to animate a moving object, they set up a sequence of graphics cards, told the EXEC where this sequence was stored in memory, how long it was, and the rate to change the images. The EXEC handled the rest. If programmers wanted to move an object from point A to B in three seconds, the EXEC could do it. If programmers wanted to trigger an event or process when one object hit another, the EXEC could do that too.

The EXEC also had "an added benefit—it forces a structure onto people's programs, so that all programs have the same general structure."[16] This structure was both specific and general. It was specific in the sense that cartridge programs that used the EXEC had to follow protocols that the EXEC implemented—for example, populating specific databases for moving objects that the EXEC required. It was general in the sense that the EXEC erected a structure on the hardware, molding it, emphasizing some aspects while de-emphasizing others. For instance, Rolfe noted that by handling interrupts, "the EXEC is a metronome." The STIC's interrupt signal, the system's mechanical heart beating sixty times a second, establishes the basic timing for Intellivision games. The EXEC makes this heartbeat useful. It does so by defining a "tick," normally representing a temporal interval of three interrupts (i.e., the time it takes the EXEC to update moving objects and check interactions). Thus, while there are sixty interrupts per second, there are twenty ticks per second. The "tick" is a temporal unit that can be used to activate other EXEC routines and even create timers that call code. This can be useful for continuously triggering code that is needed for gameplay. For example, *NFL Football* defines a process called EVERY1, which calls numerous routines every tick to check if the player-controlled character is out of bounds, to handle the player's movement and directional control, and to check if the playfield should scroll and process the scrolling.

The EXEC could offload a significant amount of necessary code from Intellivision cartridges. But while saving space on cartridges was the EXEC's original purpose, the EXEC also created a common language for Intellivision design—an emergent set of assumptions and practices that shaped not only videogames but the everyday work of programmers. The EXEC's library of code and methods, the temporal idea of a "tick," and the way it facilitated use of moving objects created a general framework for videogames. Thus, the EXEC acted as "a great documentation feature, as it enables someone to pick up somebody else's program and immediately understand how the pieces hang together."[17]

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"Your Friend, The EXEC," Intellivision's introductory programming manual, was aptly named. A friend offers support, assists in difficult situations, and is always there if needed. Like a friend, "the EXEC will leverage you to be more than you could have been," Rolfe explained. The term "user friendly" has been traced to Harlan Crowder, an IBM engineer who in the early 1970s "proposed that a computer program be gauged not just on how well it solved a problem but on how easy it made the lives of the people trying to solve it."[18] If judged by these criteria today, the EXEC would be deemed successful on both counts. It solved the problem of limited cartridge space so crucial at the time and also provided scaffolding that helped programmers make videogames, like a ladder helps someone paint a house. While "Your Friend, The EXEC" explained that the EXEC was intended to save space and not necessarily make "programming easier," in practice it did just that.[19] This unintended outcome was a helpful side effect, contributing to an emergent community of programming expertise.

Even early on at APh, the programmer Peter Kaminski recalled how "as a summer intern you start, and they say, 'Okay here's the EXEC manual. Take two days and write a game.'" Indeed, Brian Dougherty, an engineer and programmer at Mattel Electronics, explained that the EXEC allowed someone with "no knowledge of how to write a videogame to get something working quickly," avoiding the problem of having them "understand every inch of what the hardware does." Mattel programmer William Fisher concurred, explaining it "gave us a tremendous amount of flexibility" and "made it a lot easier to do our jobs." Programmers who eventually left Mattel Electronics for third-party developers brought knowledge of the EXEC's benefits with them (chapter 12). Dougherty, who departed Mattel to cofound the third-party developer Imagic, also wrote a new EXEC for Imagic's Intellivision games, explaining that even outside Mattel Electronics, an EXEC "was a great way to take somebody right out of school and get them up to speed."

Strikingly, management at both Imagic and Mattel Electronics saw Intellivision's "friendliness" as a point of contrast with the Atari VCS. At Imagic, Dougherty emphasized that the Atari programmers "would work for four months writing a game," while "I had these guys coming in from Berkeley who would, overnight, recreate the game because of the power of what you could do on Intellivision." At Mattel Electronics, managerial timelines assumed that Intellivision programmers should have "rough gameplay" by week two, but for those developing Atari cartridges, "rough, rough gameplay" was not expected until the third week.[20]

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The EXEC's friendliness was augmented by training programs that emerged with it. Rolfe said he programmed the EXEC "during the first half of 1978 and it kind of got finalized by the summer of 78." To demonstrate how an onboard EXEC could support a game program to do astounding things with limited code, around March 1978 Rolfe created Trivia. Taking up only three pages, this short program showed "an animated running man controlled by the keypad, with a visible result when the man interacts with a mine object."[21] Rolfe called it Trivia "because it was a trivial program," and cutting the name to "Trivia" popped to mind because PDP-10 workstations used six-letter file names.

Despite its name, Trivia was not trivial: the demonstration program became a training program. Summer hires at APh needed to learn how to code for Intellivision. Rolfe began modifying Trivia, naming the slightly revised version "Killer Bees"—in the news at the time—to give to summer hires. They learned to code Intellivision videogames by making variants of this program, one of which they named "Flyswatter."[22] Loughry recalled the goal as learning to "put up a moving object, which was the flyswatter, another moving object, which was a fly, [then] read the keypad, move the two of them around and detect an interaction." Rolfe added that new hires would thus "create some slight variant on the Trivia game so they'd have a feel of how to program. Then they had an intellectual beachhead from which to invade the wonderful new world of Intellivision programming using the EXEC and launch into a real game."[23]

Trivia became part of the technology transfer from APh to Mattel Electronics. New hires began using Trivia to learn game programming, using a revision created by John Sohl (who had worked in APh's offices before Mattel created its own programming team). Sohl's version made the training program more friendly and accessible, adding references to helpful sections of "Your Friend, The EXEC" in the program comments and even adding an image to show programmers how graphics worked (see page 131). Playing off "Killer Bees," Sohl named this revision "Attack of the Killer Tomatoes" after the 1978 parody movie (shortened to "Killer Tomatoes").[24]

The change from Trivia to Killer Tomatoes was linked to contrasting organizational cultures. At APh, Trivia was a quick way to learn how to create a "trivial" program. At Mattel, Killer Tomatoes also became a toy, recalling Mattel's long history in the business of play. During his first days the programmer Rick Koenig recalled being told, "'Here's Killer Tomatoes. Study it and play with it.'" When first hired Connie Goldman was temporarily housed in a Mattel Toys area, "surrounded by Barbie people in this little cubicle." Goldman was also given Killer Tomatoes and recalled "just playing around with the programming. I thought these killer tomatoes were just

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these red blobs and they should be improved upon. And so I turned the red blobs into mice and animals." A couple weeks later supervisors checked in, "looking at all these characters I had developed and animated. They were impressed." This launched Goldman's specialization in graphics, and some graphics in later games (like *Thunder Castle* by Goldman and Dave Warhol) were developed from these early characters.

Killer Tomatoes helped transform the EXEC into a shared language for videogame design. Programmer Eddie Dombrower noted, "The idea that there's a fully baked game that you can go in and tweak was actually a pretty cool part of the culture. Everybody had this really interesting frame of reference after your first couple of weeks." Introduced through Killer Tomatoes, the EXEC became an unexpected "friend"; a technical object burned into the materiality of Intellivision's chipset became a set of social practices. By easing game development, the EXEC and Killer Tomatoes allowed Mattel Electronics to covet creativity beyond computerese and hire "Renaissance people," as programmer and manager Don Daglow put it. Stifel was one such "Renaissance" figure. Stifel's "Game Factory" (with which we opened this chapter) allowed users to design simple games and came with an example—"Guess Who's Gonna Be Dinner?"—which involved a caveman avoiding dinosaurs. This had been "my first Killer Tomatoes program," Stifel noted, and "when it came time to come up with a pre-packaged game in 'Game Factory,' I tweaked that."

The Decle

While Stifel programmed Mattel Electronics' final cartridge, Daglow was one of the division's earliest hires. Daglow had experience creating games on mainframe computers, but he did not know how to program assembly code for microprocessors. To make Intellivision games, Daglow recalled Sohl teaching him assembly language "well enough that I could go out and write a cartridge." Daglow went on to create influential cartridges including *Utopia*, one of the first real-time strategy games.

This form of informal training and assistance eventually worked in concert with Killer Tomatoes and Trivia. As noted earlier, these programs would ease new hires into learning Intellivision programming—for example, giving them a sense of how the EXEC worked, how it helped to structure programs, and how to load and display graphics. The trainer programs would also be programmers' first encounter with assembly language for Intellivision's CPU, the CP1610, in which they would write their programs.[25] Writing assembly language code was a difficult task. Programmers needed to understand a variety of instructions, how they worked with

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internal CPU memory registers and external memory components, and how they manipulated bits of information when executing and processing data. While the CP1610 was like other microprocessors at the time—requiring arcane knowledge of the inner workings of the digital machine—it also had features that eased programming. "It was a really interesting design," Fisher said of the CP1610, "and I think it worked really well. It was a strange one, but it had a lot of power and it allowed us to do some things a little bit easier than on the other machines."

When describing the CPU in 1975, the chip's designer Jeff Stein said that "programming is 'very comfortably' done at the assembly level."[26] Many programmers concurred. Brian Dougherty explained that compared to the 8-bit processors of the day, the CP1610 was a "way more powerful microprocessor from the instruction capability point of view and how easy it made programming," a point supported by Sohl, who said "the CP1610 was a pleasure to use" and "very easy to program." Other programmers like Newstadt and Ray Kaestner explained that they would have used any microprocessor to write games, but both noted that the CP1610 eased programming. The CP1610's power and relative ease of use were not factors in the decision to use the microprocessor in Intellivision's chipset—General Instrument (GI) used it because they had it. However, the CP1610's power and ease of use did facilitate game programming, contributing to Mattel's ability to hire programmers with creative backgrounds.

The CP1610's power stemmed from it being a 16-bit processor. Like the PDP-11 minicomputer that partially inspired its design, the CP1610 has eight 16-bit registers, R0 through R7. A register is a memory area internal to the CPU and quickly accessible. It is within these registers that data and instructions for the CPU are read, interpreted, processed, and manipulated. The 16 bits means that the registers can hold and manipulate larger strings of 1s and 0s than the 8-bit microprocessors popular in the mid-1970s. The extra bits allow for more powerful and efficient calculations of larger numbers—a feature needed, Stein said, since the CPU was designed to perform complex calculations required in industrial control systems (chapter 2).

Moreover, the eight registers are "general purpose."[27] This means that particular registers are not tied to specific functions and instructions. In truth, some of the CP1610's registers have specialized uses. For example, R7 operates as the program counter that points to the location in memory that holds the current program instruction, and R6 is a stack pointer that contains the next available location in memory where a stack of data is maintained. However, in theory, these registers could also be used for other general functions. For instance, a programmer can use the assembly language operations ADD (addition) or SUB (subtraction) with any of the eight

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registers—a fact that makes programming the CP1610 more flexible.[28] Newstadt explained that "keeping the right values in registers avoided write/reads from memory," making for more efficient and faster programs.[29] Indeed, having numerous registers available provides options for temporarily storing and manipulating data. For example, a routine that checks the hardware for collision detection in the EXEC uses all eight registers. The routine begins with four values stored in R0, R1, R4 and R5, makes use of R2 and R3 for processing purposes, and relies on R6 to manipulate the stack and R7 to monitor the current program instruction.

Though flexible, the CP1610 is a bit of a strange machine. The "10" in its name designates that the chip uses an instruction set that is 10 bits wide—not 8 bits, the industry standard for microprocessors at the time, nor the more powerful 16-bit encoding. Rolfe noted in "Your Friend, The EXEC" that experts disagreed as to whether Intellivision should be considered a 16-bit or 10-bit system.[30] Indeed, the CP1610 was a hybrid technology that combined the processing power of 16 bits with a 10-bit instruction set. While the CP1610 has 16-bit wide registers to handle mathematical operations, each instruction or operation code (opcode) uses 10 bits of information. These opcodes form the assembly language used by Intellivision programmers to control the microprocessor and write code for games. The Master Component's EXEC ROMs and game cartridge ROMs were thus 10 bits wide, to store 10-bit instructions. While working on Intellivision's EXEC operating system at APh, David Rolfe named this 10-bit word a "decle," analogous to an 8-bit "byte." As Fisher noted, the world of Intellivision was "the only place in the tech universe that ever used this term."

Why use a 10-bit instruction set for a 16-bit processor? The simple answer is cost and complexity. Stein explained that "the original instruction set based on 16-bit words was too complicated to implement in a single-chip processor" and "would not even come close to fitting on a silicon die size that GI could produce."[31] The 10 bits provided a larger, more detailed instruction set than the standard 8 bits could capture, and the added cost was acceptable. While it would require slow kludges at times—such as requiring using two decles to store a single 16-bit value—using 10-bit ROMs to store videogame instructions in the EXEC and cartridges turned out to be felicitous for GI.[32] Unlike 8-bit ROMs, 10-bit ROMs were not readily available in the market. If millions of cartridges and Master Components needed them, GI would likely be the only source. As Sohl put it, for GI an additional benefit of this design was that "Mattel was chained forever" to them.[33]

While a 10-bit-wide instruction was an anomaly in the world of computers, it was a feasible solution to the material limitations of chips at the time. As Fisher put it, "We can get 4 times the number of opcodes if we

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TABLE 5.1. 10-bit instruction encoding using an internal "register to register" operation.

Bit Numbers	**9**	**8 7 6**	**5 4 3**	**2 1 0**
Function	External or internal	Operation	Source register	Destination register

use 10-bit wide words." That is, an 8-bit opcode allows for 256 different instruction possibilities (256 different combinations of 1s and 0s), but the extra 2 bits in decle-sized encoding provides 1,024 possibilities. The 10 bits provided an elegant solution to designate two CPU registers and an appropriate set of operations in a single instruction word. "Since you had 8 registers," Fisher explained, "the source is 3 bits, the destination is 3 bits, and that leaves you with 4 other bits to make up add, subtract, move, and stuff like that." For example, table 5.1 describes the general format of an internal, register-to-register operation, meaning that two registers containing values are being used to execute an operation.[34] Programmers might write the assembly code "ADD R3, R5" in their videogame code, which means "add the values held in registers 3 and 5 and put the result in register 5." For the CPU, this code would look like a string of bits, 0011011101, that encodes destination register 5 (101), then source register 3 (011), then the ADD code (011), and a final 0 to indicate it is an internal operation using information from its internal registers, not memory outside the CPU.

Indeed, the instruction set elegantly handles identifying two registers and the operation the CPU should perform. If the instruction set was encoded with only 8 bits, it could not have easily supported identifying eight registers, would have encoded less operations, or would have required programmers to write additional instructions to accomplish their goals. The 10 bits made encoding instructions more robust, providing room for more opcodes to facilitate the CPU's processing, ultimately easing programmer labor. As Intellivision expert Joe Zbiciak noted, with its eight versatile registers and orderly instruction set, the CP1610 allowed for "flexibility in programming."

Bypassing the EXEC

The CP1610's design and instruction set, the EXEC, and even training programs eased the learning and labor of game development. As programmers became more familiar with Intellivision's technical features, they pursued more advanced techniques. For example, while the EXEC was part of the

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ladder of Intellivision game design, programmers increasingly chose to skip this rung. The EXEC's benefits came with a catch. As Rolfe observed, it was "both an asset and a little bit of a straitjacket. The things which the EXEC made easy to do tended to get done. The things which the EXEC didn't make easy to do tended not to get done." Mattel programmer Mark Kennedy suggested these constraints could suppress some programmers' ability "to think outside the box," leading to a mentality that "we write Intellivision games using the EXEC, so we have to use the EXEC." In fact, programmers did not have to use the EXEC for their games.

Rolfe wrote that while the EXEC "usually helps, it can sometimes be a pain."[35] The EXEC was a friend, but sometimes a friend can be a pain in the ass. Rolfe described it as a system of roads that both eases and constricts travel. The metaphor suggests that cars follow predefined pathways. In theory, the fastest route might be "offroad," directly from point A to point B. However, while roads can be circuitous, they provide clear, safe routes. The EXEC made some destinations easily accessible (like animating moving objects) and others harder to reach (like animating background graphics).

As discussed previously, the EXEC handles many low-level hardware tasks, like managing interrupts to update Intellivision's graphics chip or polling hand controller input. Offloading this work to the EXEC was safe but slow. Rolfe explained that "Interrupt programming is like doing a trapeze act without a net," and if you "make mistakes, your program will crash and burn and you will never figure out why."[36] The EXEC provided roadways for this difficult labor, so programmers did not need to work with interrupts. To be safe, Rolfe spread the EXEC's labor over multiple interrupts instead of trying to do all the labor of updating the STIC at one time. This way, the CPU could finish updating the STIC safely during vertical retrace without the possibility that time would run out and a display error would occur. During one interrupt moving objects 0–3 are updated; during the next, 4–7 are updated; during the next, collisions between moving objects are recorded.[37] This structure sets a "speed limit" when using the EXEC: updating moving object positions and checking controller input occurs only twenty times a second, not the technically possible sixty times a second which would occur if a program updated all moving objects and checked controller input during every interrupt. In hindsight, Rolfe mused, "Maybe I was being overly cautious." He could have programmed the EXEC to update all the information that the STIC needed over two interrupts instead of three. In the end, safety and stability triumphed over speed.

In search of faster and more responsive games, programmers started bypassing the EXEC. This meant that moving objects could be updated more often. Instead of twenty times a second, once every tick, they could

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be updated thirty times a second or as fast as sixty times a second (once every interrupt). Titles like *The Dreadnaught Factor*, *Masters of the Universe: The Power of He-Man*, *Worm Whomper*, and even Rolfe's own *Beamrider* could thereby attain higher graphics processing speeds.

Bypassing the EXEC occurred more frequently after Intellivision had been on the market for a few years. Why? Programmers were becoming more familiar with the platform, and shared practices were emerging that established methods to bypass the EXEC's control. Moreover, the problem of memory limits—the EXEC's original reason for being—no longer needed solving to the same degree. Cartridge ROMs were becoming cheaper. Instead of 4KD games, 8KD and even 12KD games were now possible. Programmers could write their own code to accomplish tasks previously assigned to the EXEC.

How did programmers bypass the EXEC? "Your Friend, The EXEC" noted that "certain classes of things are hard to do, if not impossible" with the EXEC, and methods were available for "defeating all or parts of the EXEC if the user finds it unsuitable."[38] Rolfe explained that "the EXEC can run only when things are letting it run. If the program does not relinquish control, no EXEC." One way to keep control was stealing interrupts. Instead of the EXEC taking control when the graphics chip finished drawing a frame and broadcast an interrupt signal, the cartridge program would take control. Though risky, the process required to steal interrupts was relatively easy. The EXEC contained a variable called .INTDSP (interrupt dispatch) that normally contained "DOINTX" (do interrupt), which was "the address of the EXEC [interrupt] servicing routine."[39] Programmers simply changed DOINTX to their own routine address, so when the EXEC received an interrupt request from the hardware, it branched to the programmer's routine on the cartridge.

What kind of things did programmers do when stealing interrupts? They might poll hand controller input more frequently than the EXEC, as in *BurgerTime*. Or they might interact directly with the STIC, which the EXEC normally kept at arm's length. In *Pinball*, programmed by Minhchau Tran and Newstadt, the initial plan was to use the EXEC, but when Newstadt joined the project, he recalled the pinball was like "a big balloon floating around the screen. When we measured how fast real pinball machines were, things had to move fast. It was very clear we had to go beyond the EXEC." In the end, they bypassed the EXEC to create more responsive ball movement and precise collision detection but retained it for processes like displaying the score. Fortunately, pinball does not have anything like a team of football players, meaning that the program does not need the EXEC to update multiple moving objects. Thus, *Pinball* could update the STIC much faster. *Pinball* creates a "shadow STIC" in System RAM, keeping a copy of STIC registers in

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software like the ball's X and Y positions. Since the shadow STIC is always available (even during active display) its values are always changeable as the cartridge program calculates ball movement, deflections, and so on. *Pinball* replaces the EXEC's interrupt service routine with its own routine to update the STIC every frame for the ball (instead of every 3 frames like the EXEC would normally do). 60 times a second, *Pinball's* interrupt routine copies the "shadow STIC" containing the X and Y position values of the ball to the actual STIC's registers, thereby updating the ball every frame.

While an advanced technique requiring technical precision and care, stealing interrupts is also an example of a set of social practices that developed within Intellivision's platform culture. At Mattel Electronics the technique was disseminated through shared code, documentation, and seminars. A revised "Your Friend, The EXEC" was slated to include a section "Stealing Interrupts—Why, When, and How," and in July 1983 programmers taught a seminar "Beyond the Valley of the EXEC—Moving Objects."[40] Programmers had fun with the "stealing interrupt" phrase with seminar titles like "How to Steal Interrupts & What Happens If I Get Caught?" and "Stealing Interrupts and Other Acts of Larceny."[41] A description from a seminar run by Russ Haft explained "it's difficult to write a game nowadays without stealing at least one interrupt to do something fun with Your Friend, the STIC."[42] Intellivision programmers were assisting each other to descend below the "rung" of the EXEC, becoming friends with the hardware and spurring their understanding of the platform and its technical possibilities.

Forging the Tools

When assigned to create "Game Factory," Stifel recalled Andy Sells, his manager at the time, saying, "'We want you to make Mr. Color for games.' And that was my marching orders." Stifel understood the request because he was already familiar with Mr. Color—a tool allowing programmers to design graphics on the Intellivision console. It was fitting that the final title completed at Mattel Electronics, "Game Factory," was a "tool" that allowed players to create their own videogames: programmers had been forging such tools for their everyday work. This emerging "tool community" contributed its own rungs to Intellivision's ladder of design.[43] Notably, these rungs involved Intellivision serving recursively as its own development tool.[44] Over and over again, improved tools were coded by the programmers themselves, using the console as the interface. Intellivision's platform culture emerged not only in relation to the actual system and its technical affordances but also in relation to the tools that programmers developed as a support system to facilitate design.

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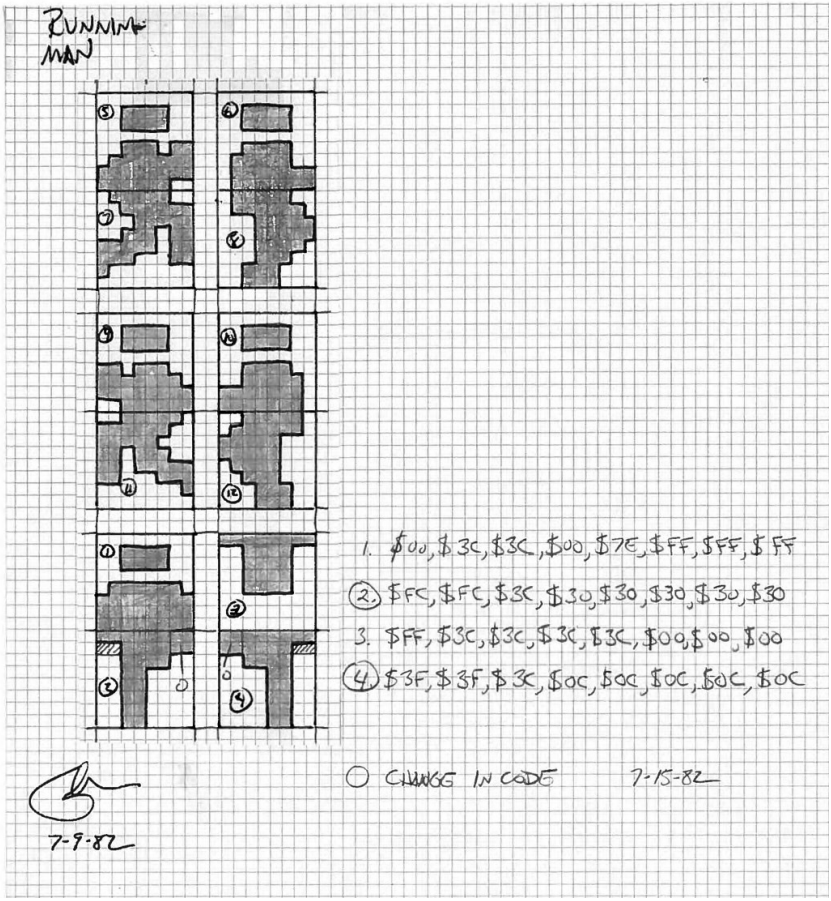

5.1 Alternative "running man" draft images (by Joe Ferreira (later King)).

Mattel Electronics and APh's development systems and tools were extensive, often distinct, and always changing. Multiple hardware systems, test harnesses, debuggers, and software programs were used by Intellivision programmers—sometimes simultaneously—reflecting Intellivision's expanding platform culture.[45] For example, graphic design underwent multiple evolutionary stages in terms of tool development. The programmer and graphics designer Joe Ferreira (later King) recalled that graphics were often hand-drawn in pencil (figure 5.1): "We had special large pads of graph paper that were designed around the actual resolution of the screen. That graph paper was broken down into individual [graphics] cards with the individual pixels."

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Ferreira added that after a design was drawn, "the next task was to break each one of those cards down into assembly code. It was brutal." APh programmer Ken Smith noted that for *NBA Basketball*, in addition to drawings of the court, the Mattel industrial designer Dave James created "flipbooks" showing how the players should be animated: "Everything was hand drawn. And then your job is to write a program that implements this on the Intellivision in a 4K cartridge."

Up to around 1980, there were no computers at Mattel suitable for putting graphics on a cartridge. Nugent recalled that to see graphics on screen the pixel paper would first be sent to APh. "Somebody had to physically drive from Hawthorne and then they'd put it on the screen and take a day or two, and then someone had to physically drive it back again. It would be sometimes a week turnaround." APh had developed a graphics system known as PECO ("Picture Editor and Corrector"), which Loughry noted had an 8×16 array of buttons for setting moving object image bits and a 12×20 array of buttons for selecting background cards to design.[46] A similar device, the Graphics Development System (GDS), was built at Mattel Electronics. James recalled, "It took me forever to convince Mattel that this was a good idea and they finally built it." Like PECO, it had a dedicated monitor and a control panel with two grids of buttons for defining graphics.[47] Only one GDS was built (figure 5.2).

Given limited access to the GDS, Eric Wels began work on a new graphics development tool that "moved the graphics editing to the Intellivision itself" (figure 5.3). Wels added that the tool was an improvement on the GDS, which "wasn't very quick. You weren't as free to experiment. And so getting the art editing tool onto the Intellivision was an important step." The new program allowed programmers to arrange tiles to compose backgrounds and moving objects, and work could be saved for future sessions. A "main composition" mode previewed the final graphics.[48] While working on the program, eventually named "Mr. Color," Wels would visit Goldman's cubicle "and bug her about the program. She was really a great artist. More than anybody, she helped me with that program."

Mr. Color was released in August 1982.[49] Stifel emphasized that it quickly "became the tool for all graphics artists to use," and Haft called it "a godsend." Goldman emphasized that when working with tiles, "you could place those tiles or flip them, and it was so much easier to do a big screen that way." For instance, Goldman noted that for *Thunder Castle*, "If you look at the dragon, I was limited in tiles, but I managed to use flips a lot so I could reuse them over and over again" (figure 5.4). Without Mr. Color, such a complex title screen would have been difficult and tedious to produce. Moreover, tools existed to take the output files from Mr. Color and generate an assembly file

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5.2 The original Graphics Development System (image by David James).

listing—including code that would work with the EXEC—so "you now have the beginning of a game."[50]

Mr. Color remained a mainstay of game design, a technological element of Intellivision's platform culture that shaped hiring and labor practices. Goldman noted how Mattel Electronics originally could not hire artists as graphic designers "because there were no graphic programs. You had to be a programmer to do graphics. After [Mr. Color], they were able to hire artists who didn't know how to program." Mr. Color had direct consequences for the emergence of specialization. By 1983, it was possible to address a memo to "Intellivision programmers and graphic designers" as distinct kinds of staff.[51]

The history of sound development tools roughly paralleled the graphics tools. At APh, Loughry noted "the sound engine was done by Hal Finney. We never asked [Mattel] for help with sound. You did your own sound or you got somebody to do it for you from APh." Creating sound and music originally required "hand coding" sound data in assembly—"a ridiculous way to have to write music and sound effects," Sells recalled. Programmers could not craft sounds in real time. At Mattel Electronics, Daniel Bass described adjusting

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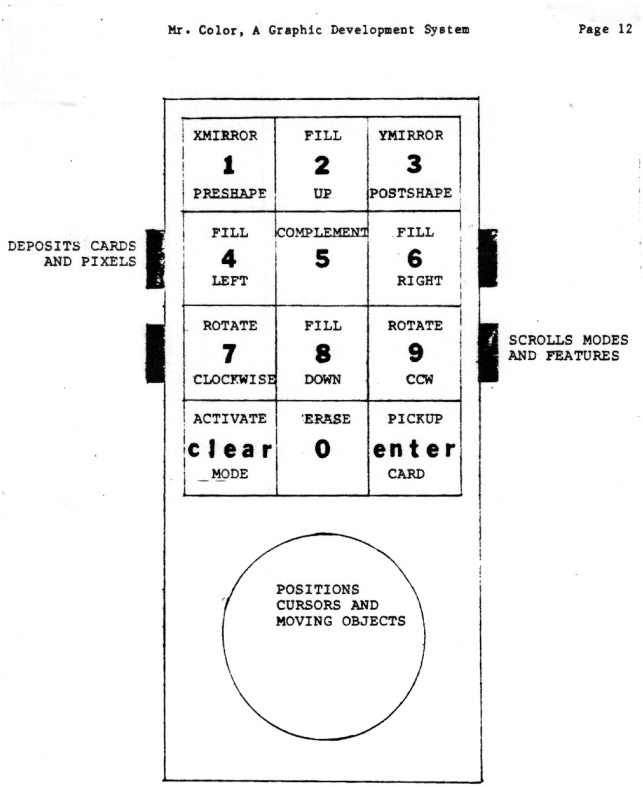
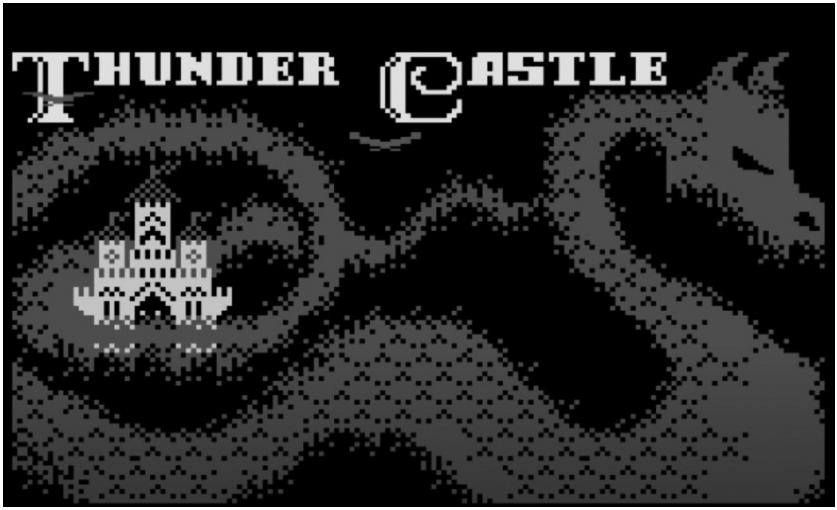


5.3 Drawing from memorandum showing how Mr. Color uses the hand controllers (by Eric Wels).



5.4 *Thunder Castle* title screen (by Connie Goldman).

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parameters like period and duration but then realizing a sound "was about a hundred microseconds too short." One then had to "edit the code, make it a hundred microseconds longer, recompile it, relink it, download it, play the game," only to realize it was now too long. Like Sells, Bass understood that "this is a really stupid way to do sound."

Thus, tools were developed at Mattel Electronics to facilitate composition and encoding of sound, such as Bill Goodrich's "Sound T" program and Bass and Sells' successor tool, "Mr. Sound," released in March 1983. Mr. Sound was "inspired by the pioneering efforts of Eric Wels in 'Mr. Color'" and like Mr. Color, used the Intellivision controllers for input.[52] It allowed programmers to work with sound code interactively, "developing or modifying sounds, and then uploading the results."[53] It came with a library of sounds that programmers could copy and manipulate to insert sound segments. This was a significant improvement over previous methods of sound development.

Mr. Color and Mr. Sound exemplify some of the highest rungs on Intellivision's ladder of design. They turned the console itself into a tool for making videogames, reshaping the labor of design in the process. Yet these tools could only come into being because of lower rungs like the STIC, the EXEC, and the CP1610 itself. It was with second-generation game systems—and the platform cultures that grew up beside them—that "game factories" could come into being in everyday practice. The emergence of the game designer as profession and selfhood built on embedded practices that were collaborative and involved support systems of technology, documentation, and social interaction. In the following chapter, we explore how this emergence took form in the everyday work of videogame design.

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Becoming a Videogame Programmer at Mattel

6

In the previous chapter we discussed Intellivision's platform culture, within which programmers learned what Intellivision could do. This included exploring and shaping the platform and even creating tools for game development. These practices can be understood as what Aphra Kerr has termed a "production culture," invisible to the consumer plugging a cartridge into their console.[1] All platform cultures include production cultures. Investigating production cultures is crucial to platform studies since a "critical reflection of video game production can uncover the economic, cultural, and political structures that influence the final form of games."[2] Moreover, closely examining production cultures and the "design history of video games," as Raiford Guins called it, helps account for "the full spectrum of design practices."[3]

Moving from programming to programmers, this chapter extends our analysis of Intellivision production culture by examining how programmers became videogame designers in "Applications Software," the group that arose within Mattel Electronics to make new titles for Intellivision. We explore how designers were hired and learned to make games, given that very few had prior experience since videogames were simply too novel. Making Intellivision games involved not just new work but a new workplace that was the center of development: in this mainframe era there were no desktops or laptops, and programming took place almost exclusively in the office. Contrary to the myth of the lone programmer, from the outset, this work involved emerging norms and dynamics of collaboration.

In the Introduction, we discussed how Intellivision was shaped not only by prior videogame systems but also by Mattel's history of designing and

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manufacturing toys. In this chapter, we expand this analysis by tracing how this history shaped the social relations and everyday practices of Applications Software programmers. As a legendary "funny farm" of creativity, Mattel's Preliminary Design department for incubating new toy ideas was a key precedent for Applications Software (chapter 1). Preliminary Design provided a template to foster brainstorming, an ethos of work as play, and procedures for selective engagement with managers and marketers. When Mattel Electronics began separating from Mattel's Toy division in 1978, it emerged from Preliminary Design and included a new department called Design and Development (D&D). Richard Chang, previously a Director in Preliminary Design, became the head of this new "department of 30 engineers, programmers, industrial designers, and writers" responsible for handheld games and Intellivision software.[4] A few years later, Applications Software would emerge from D&D.

Eggs in Mattel's Basket

APh Technological Consulting (APh) played a crucial role in Intellivision's development, a point we stress throughout this book. While we focus on the production culture of Applications Software in this chapter, we frequently compare it with APh, since APh's existence and success was the primary force driving Mattel Electronics to create its own team of programmers. As Intellivision was developed and brought to market, APh was the center of game design for the console. All of the original twenty cartridges listed in Intellivision's 1980 brochure were programmed at APh, and the consulting firm continued to produce many games under the Mattel Electronics brand.

However, this dependence made Mattel Electronics executives increasingly uncomfortable. Heather Edison (later Brendel), who eventually became Chief Executive Officer at APh, emphasized that Mattel Electronics had begun "to see that we were getting smarter, that we were getting very close to saying, 'From now on it's going to be not $12,000 [per game] and we're done. It's going to be $100,000 and royalties." When Mattel Electronics sought to internalize videogame development, Edison recalled one APh meeting with Mattel managers where "they started by saying, 'We just want you to train our programmers.' They didn't say, 'We want to cut our relationship with you' so much as they were saying, 'We're too dependent on you. We'd like you to share your technology.'"

The earliest Mattel programmers spent considerable time in APh's offices since there were not yet tools for videogame design in D&D at Mattel. Brian Dougherty, hired at Mattel before Intellivision was released, recalled, "There was probably a four- or five-month period that my job was driving

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to APh." Glenn Hightower, founder of APh, allowed Mattel's visiting staff to use their equipment, but for the most part there was no direct collaboration. For example, Mattel Electronics programmers Mike Minkoff and Rick Levine worked on *PBA Bowling* at APh, soon joined by John Sohl. Sohl recalled that they "sat in a room by ourselves at the far back of the building and people would be polite, perhaps. Not really effusive, and they wouldn't be wandering in and out talking shop. So we were sort of in Siberia there in APh." Despite such separation, circulation of ideas could occur. For example, APh staff Larry Zwick was programming an *Asteroids* clone a few desks over from Sohl, who eventually designed *Astrosmash* (based partly on *Asteroids*).

At this point Gabriel Baum was working in London, developing language education programs for the Atari 400/800 home computer. Seeking additional customers for his business, Baum met with Josh Denham, President of Mattel Electronics, to discuss Intellivision. Baum recalled, "I went on a rant about the problems of managing the development process for creative people, how different it is from managing the process from an engineering perspective." Baum added that he must have been persuasive because Denham recruited Baum to join Mattel Electronics in January 1981 as head of the "Intellivision Programming Group." By the end of the year, this group was known as "Video Applications Software Programming," commonly shortened to "Applications Software."[5] Baum recalled that "the issue for Intellivision management was that all their eggs were in one basket, and that was APh. They were very anxious to form an internal development group."

Baum initially reported to Chang within D&D, yet since Chang directed many operations and Baum had specific experience with managing software development, Baum's hire made sense. As Intellivision programming grew at Mattel Electronics, Baum pushed for autonomy. APh programmer Tom Loughry noted that around 1982 Baum replaced Chang representing Mattel Electronics at meetings with APh, and in April 1982 Applications Software officially broke away from D&D to become an independent group.[6] Chang had emerged from Preliminary Design managing the creative development of toys and was a key force in extending this institutional heritage to Intellivision. Baum's cultivation of Applications Software built on this tradition, exporting a paradigm of playful, protected, freewheeling innovation to videogames. Baum emphasized that Denham was "very receptive to my approach to creating 'a company within a company' as I sometimes put it. I suspect that cultivating creativity in a Preliminary Design-type group was in the DNA of the company, and I was able to build on that approach."[7] However, Applications Software's autonomy signaled growing organizational conflict as electronics became further separated from Mattel's institutional history with toys.[8]

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Even while Mattel Electronics internalized game development, work with APh continued. In May 1982, while Intellivision was booming, there were twenty-five titles in progress, and twelve of these—almost exactly half—were under development at APh.[9] The production culture of Intellivision game design was thus dually located, extending to APh and its Caltech roots (chapter 1), and also within Mattel Electronics.

Hiring the Creative Team

Bringing videogame design within Mattel Electronics meant hiring and managing people for a job category that in large part did not yet exist. This process was deeply tied to Mattel's location in Southern California, with its nexus of engineering and entertainment. "Southern California is a land of unimaginable variety, beauty, and excitement," read Mattel's promotional recruitment materials, an enticing location associated with sunshine, entertainment, and fun.[10] The marketing researcher Craig Spitzer noted that "Los Angeles sounded like heaven on earth" when he was recruited from Chicago, a point echoed by other marketers coming from the Midwest and East Coast. However, for programmers and engineers, a common pattern extending back to Mattel's early years was for the playful world of toys and games to fuel a brain drain from aerospace, particularly military aerospace contracting. Many programmers and engineers either came from that domain or joined Mattel rather than pursue a career in aerospace engineering.

Most prospective Intellivision programmers already lived in the area. For instance, Stephen Roney was raised in Santa Monica and Eddie Dombrower in Long Beach (Dombrower recalled driving by "the old Mattel sign on the 405 freeway. It was an icon"). A majority of Applications Software programmers received undergraduate degrees from Southern California institutions. A few majored in computer science, but since the field was new, many received degrees in electrical engineering. Moreover, many programmers were in their early twenties when hired, often as their first full-time job. In the world of contemporary videogame design, programmers are also often in their early twenties when hired. However, during the second generation, the very idea of programming games was in its "youth."

One reason many programmers and engineers were from Southern California is that Mattel Electronics primarily recruited for these positions via local newspaper and radio advertisements. Many advertisements did not even mention experience in game design or programming, offering instead the chance for engineers to use "creativity" as well as "a lot of enthusiasm, imagination, and energy."[11] For example, in 1981 Roney was working at Hughes Aircraft, and Mattel Electronics was headquartered on the other

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side of the freeway. A sign in front of the building stated they were seeking Intellivision programmers, and Roney decided to apply. Concerned that six years at Hughes Aircraft would imply the need to pay him a high salary, Roney said, "I took my resume and crossed out my top-secret clearance and wrote that I had a hundred board games."[12]

However, the initial screening process focused on technical ability, not game design. Programmer Bob Newstadt recalled how "Mattel couldn't hire people who had already done home videogames. It was too new." Mark Urbaniec, another Mattel programmer, confirmed that "we didn't hire game programmers. We didn't hire game designers. Those didn't exist. You are hiring somebody who worked on a guidance system for a missile or was programming a part of a payroll program." Using what became known as the "Minkoff Measure" (named after the programmer and director Mike Minkoff), Roney recalled that "they gave you a block of assembly language code and asked you what it did. It was inclusive OR."[13] This operation was not in the instruction set of Intellivision's CP1610 microprocessor, so programmers would need to understand the code to describe its function.

Programming ability, however, was not the only consideration. Creativity was a valued asset. Programmer Steve Ettinger explained that he was a "total liberal arts guy" in college and failed the Minkoff Measure, but through persistence was able to be hired. Baum recalled interviewing other candidates who passed the Minkoff Measure, and "if they didn't come up with an arts subject they were passionate about, I lost interest." Prospective programmers needed a touch of the playful, evidence of passion in other aesthetic and cultural pursuits. Indeed, the technical structure of Intellivision's platform eased these hiring practices: as we described in the previous chapter, Intellivision's hardware, operating system, tools, and training made programming more accessible. Thus, Baum sought to hire individuals with backgrounds and experiences in addition to engineering, from musicians and visual artists to Shakespeare experts and Renaissance role-players. Dennis Marchand, Director of Recruiting, recalled Baum emphasizing that "I need to hire people who are creative and they don't sit in that engineering structure of just A + B = C." Indeed, Mattel Electronics' 1982 recruitment materials, titled "The Creative Idea," consistently emphasized the importance of creativity entwined with technical innovation. The brochure explained that R&D programmers and engineers "should be innovative and creative, with a mind that thinks ahead—to explore the future, and the unknown."[14] These hiring practices reveal a prehistory of what is now often termed "playbor"—the blurring of work and play—and link to Mattel's tradition of valorizing creativity, one source of the "creationist capitalism" pervading the contemporary digital technology industry.[15]

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"The Creative Idea" brochure also linked creativity to a diverse workforce, with the cover showing three women (two of color) and five men (three of color). Mattel had been cofounded by Ruth Handler. Handler was no longer with the company during the time of Intellivision, but there were some female executives in Mattel Toys. There were also female staff members in Systems Software and other divisions outside and within Applications Software, including the Educational Products group headed by Mona Theiss. Moreover, there were a significant number of women working on Intellivision marketing, including women of color like Audrey Leeks and Karen Terry. As an industrial engineer working in the Operations division, Linda Bruce found that Mattel was "forward-thinking everywhere," but "in Operations, women were not as easily advanced." Sharon Hartley, who moved from Mattel Toys to Mattel Electronics to direct marketing for handhelds and eventually Intellivision, noted that in leadership positions "there were some women, but there was a much, much better balance in Toys. Electronics was still very much a man's world." The Product Manager Kathy Austin Lockton concurred with this assessment.

Applications Software hired a considerable number of women to work on Intellivision. Some were programmers, for instance, Connie Goldman (*Thunder Castle*), Julie Hoshizaki (*Thin Ice*), Minhchau Tran (*Pinball*), Ji-Wen Tsao (*Shark! Shark!*), and Jane Terjung ("Advanced Dungeons & Dragons: Tower of Mystery" for Atari). Others worked in design or coauthorship roles—labor that also required programming knowledge—including Peggi Decarli, Monique Lujan-Bakerink, Michelle Mock, Karen Nugent, and Karen Tanouye (later McConathy), among others. Applications Software staff noted greater gender inclusion at Mattel Electronics than at positions they held afterward. For instance, Dombrower recalled, "There were more women in that group then there were the following years later as I moved to work with Electronic Arts and Activision. And I mean women in the production part of it."

Despite this relative gender inclusion, like other videogame companies at the time, a masculine ethos predominated. This can be seen in the informal humor that circulated among at least some programmers. For example, one practical joke contained signed pictures of scantily clad women wrestlers from the adult entertainment industry, written to Mattel Electronics executives.[16] An accompanying note satirized "the cause of women's liberation" and joked that the file of images would "accurately and insightfully depict the true essence of the female psyche" and "encourage and support the attainment by women of heretofore unforeseen levels of intellectual achievement."[17] Such materials were couched in joking "play," reminding us that playfulness can be channeled in ways that demean, diminish, and discriminate.[18]

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Mattel staff members were overwhelmingly white, but there were staff and consultants of color, including UCLA professor Gordon L. Berry (chapter 10), Black executives like Dennis Hightower (Vice President of Corporate Strategy, who for a time was United States Deputy Secretary of Commerce in the Obama administration) and Bill Gillis. About a month after Gillis was hired into Mattel Electronics as Vice President of Marketing in 1981, he was contacted by Jerry Lawson. A pioneering figure in videogames and one of the earliest Black engineers in this domain, Lawson had been the leader of the development team for Fairchild's Channel F videogame system. Lawson had left Fairchild and founded Video Soft, a third-party developer of Atari VCS games. Lawson hoped to make games for Intellivision and was seeking a marketing partner for the venture. Gillis declined but remembered staying in touch "to see if there might be future opportunities, both professionally and personally, to support each other." Gillis added they "agreed that Black executives lived a fishbowl existence—our every move would be watched closely. And should we become too rambunctious and flip out of the water, we shouldn't expect to be rescued and given a second chance."[19]

This assessment was based in part on Gillis's own employment history. Prior to Mattel, Gillis had been at RCA and recalled a white colleague informing him that another engineer was distributing Ku Klux Klan pamphlets (a confrontation ensued). Later at AT&T, he was admonished by his superior for traveling to a meeting with a white female subordinate. However, Gillis emphasized that "with regard to Mattel, I found them to be merit based and with more people of color executives than most." Emphasizing that "Mattel was indeed proactive in terms of hiring people of color,"[20] Gillis "made it known to Human Resources that I intended to hire minority candidates" and brought in staff like Terry and Leeks.[21] Other executives of color included Richard Chang and Ramon Fuentevilla, Vice President of Regional Field Sales. There is no record of openly LGBTQ staff, but other forms of diversity were represented. Gillis noted at least two staff used wheelchairs, emphasizing that "if you saw the entire staff, you could immediately recognize that 'wow,' this is different even for that time."[22] Within a context of male and white normativity, there were forms of organizational diversity that pointed toward a broader vision of the creative human working within the world of consumer technology.

Half Stress, Half Party

In 1988 programmer Don Daglow recalled the Mattel Electronics workspace from half a decade earlier, writing, "Picture a building converted from an old

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Hot Wheels factory with a second floor added to the interior to hold the game designers . . . a seemingly endless sea of cubicles beneath a corrugated metal roof and exposed air conditioning conduits."[23] Within this space, programmers were learning to code Intellivision games and managers were learning how to facilitate their work. When discussing programmers in an open-plan office in the mid-2010s, the anthropologist Nick Seaver emphasized how "social architectures, software architectures, and physical architectures echo each other. Walking into a tech company's offices today, one can conjure the feeling of walking into the software itself."[24] The origin of these dynamics can be traced decades earlier, to environments like Applications Software. The Applications Software offices reflected the games produced—an environment of fun and play but also one of learning, work, stress, and tension.

By late 1981, Applications Software had grown to seventeen programmers and a management structure was taking shape.[25] Baum promoted Daglow and Minkoff to Application Software Managers, dividing Applications Software into two groups.[26] The bipartite organization was fundamental, including office layout. Even Applications Software's two softball teams were named the "Daglow Decles" and "Minkoff Measures." When these two groups became too large to manage effectively—Daglow's team peaked at fifty-two—"Group Leaders" were added, each managing two to six staff members under either Daglow or Minkoff. Group Leader duties included screening new hires, training programmers, and project supervision.[27] As a group leader, Russ Haft recalled "managing the game titles that you had to deal with, and the timing and reporting up the chain, helping people when they had issues, whether it was coding issues, debugging issues, so everybody was sharing resources."[28] Because Group Leaders were always recruited from existing programmers, they could help translate between designers, managers, and marketers. After being promoted to a Group Leader, Ettinger emphasized a key contribution was that he "could talk to the other tech people and figure out how to bridge those communication gaps."

Mentorship in Applications Software was often informal. This was also the case at APh. Loughry remembered "wandering around and looking at what people were doing and sitting down. People didn't know how to tweak a game, and I was helping people out." Ken Smith, one of the Caltech undergraduates hired during the summer to code games including *Sea Battle* and *NHL Hockey*, recalled that "from time to time Glenn Hightower (or somebody else) would sit down and we'd play a game and he'd have comments about what was fun, what wasn't fun. And then you go back and eventually you ran out of the 4K. It was good enough." At Mattel Electronics, Urbaniec recalled helping new hires who were typically told, "'Now you're going to be designing and developing a game' and literally start with a blank slate. Those people

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would look at you and go, 'Do what?' There was no screenplay for the game, no flowchart for what the gameflow would be." Programmers were given the Killer Tomatoes training program and told to play around with it to begin coding their first game. Urbaniec recalled easing new programmers into the daunting task, "Don't think of it as 'Oh my God, how am I going to do this whole game?' Let's eat the elephant one bite at a time. Let's think about how the game opens. What does the screen look like? Let's make that screen."

At Mattel Electronics, such informal mentorship was facilitated by a playful, open-office environment. Hoshizaki recalled how "we could yell over the cubicle wall. Ray Kaestner was down on the other end of that row that we shared. And so he would often ask me to test his game with him. We were able to share ideas or help each other." Daglow emphasized that as a manager, "I would literally wander down the aisle, pick a cube, recognize somebody who had had a breakthrough. I'd stop in at that station and say, 'What you did was so cool. That was just great.' And because it's all cubicles, people could overhear." In addition to playing games in development, Urbaniec described how a favorite pastime was the arcade-like *Biplanes* videogame included on the Intellivision *Triple Action* cartridge, where the programmers would "have just such a good time beating each other and learning when to use a stall to your benefit, how to use the edge of the screen to sneak back from this side to that side." Daglow added, "What was great about it is you can play a game really quickly, so you weren't taking too much time off. Somebody would walk by—'you're about to play *Biplanes*? I'll play you.'" *Biplanes* became so popular that a 1982 April Fool's memo warned, "Programmers are spending too much time in their cubicles playing games [and] Bi-Planes will be erased from all system disks immediately."[29] Programmers would also play arcade games near the cubicles (including *Bump 'N' Jump*, *BurgerTime*, *Lock 'n' Chase*, *Rootin' Tootin'*, *Tempest*, and *Tron*) and sometimes the tabletop game *Dungeons & Dragons*.[30]

Within Applications Software, Baum linked play to profit, articulating a production culture of creative labor. Play and work, labor and leisure, blurred. It was what Urbaniec called "the magic of being in a place where in the cubicle next door, you would be hearing some game piece over and over. Gabriel Baum never walked by a group of people sitting there playing and said, 'What's going on?' He'd go, 'Keep up the good work.'" When an executive asserted that programmers were wasting time, Urbaniec recalled Baum responding, "I despise your Puritan work ethics. What we need is creativity. We need this flow of quality ideas that will make us products." This creativity fed a ludic culture of pranks. Programmer Dave Warhol recalled how at one point, several programmers found an enormous stuffed snake, which they proceeded to wind through the rafters of the offices, moving it every

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day a little closer to Baum's office. On another occasion Ettinger and Keith Robinson discovered a box of yellow plastic ducks at Mattel's company store, bought them all, and proceeded to play golf with them among the cubicles. "We had a lot of playtime back then," Haft recalled. When asked about the relationship between work and play at Mattel, Haft replied, "It was all the same thing," adding that it was "looking into the future in terms of some of the things the tech companies would do."[31]

Robinson wrote that when working at Mattel Electronics, "Life seemed to be half stress, half party."[32] Demanding work was coupled with child-like freedom—what Hoshizaki termed a "happy and relaxed" atmosphere. Indeed, the most consistent reflection from our interviews was that designing Intellivision videogames was fun—often described as the most fun someone enjoyed in their entire career. Warhol emphasized that it was "easily the dream job of a lifetime. I moved to be five minutes away. I couldn't wait to get in. I was in by 8:00 in the morning. I'd start to see people head out and I would be there until 7:00 p.m." This represents an early example of the "aspirational labor" that has become a hallmark of digital work, with its conflation of doing what one "loves" with creatively producing for an employer.[33]

Ultimately, Baum had to balance programmers' freedom to play with meeting deadlines. Robinson noted that "the pressure of deadlines was constant," and office days tended to be long.[34] Dombrower recalled that "it wouldn't be unusual for us to go to dinner at 10 o'clock at night at The Kettle in Manhattan Beach, and some of us would go back to work." Eric Del Sesto's September 1983 timesheets reveal only one eight-hour workday that month: twelve- or even sixteen-hour workdays were typical, and one week Del Sesto clocked seventy-six hours.[35] The programmer Karen Tanouye (later McConathy) added that "it was such an interesting place to work. You didn't just go there 9 to 5; you lived there." This was also a hallmark of Preliminary Design, where Derek Gable recalled that toy designers "loved that company so much, they would stay to midnight to get their jobs done if they had to." Baum even sought permission to provide programmers with Intellivisions to take home as "an incentive for the programmer to invest time and effort over and above that normally expected from them."[36] Play and leisure outside the office was imagined as the continuation of labor. In an era where working from home in the technology industry was nearly unheard of, Intellivision's status as a domestic product could allow programmers to expand their workday into the home.

Documentation played an important role in these emergent practices of learning, informal mentorship, and playful labor. Originally documentation was solely official, like General Instrument's CP1600/1610 manual and STIC

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specifications, and above all "Your Friend, The EXEC," which outlined Intellivision's operating system. When working on *NBA Basketball*, APh programmer Ken Smith recalled, "The first thing was they handed me 'Your Friend, The EXEC,' which set the tone of a playful place to work" given its informal, joking style. When programmers encountered novel issues, the open-office environment at Mattel Electronics itself was a resource. David Stifel recalled how "very often, Sneakernet was the way you got information. 'Hey, go talk to Bill Goodrich, go talk to William Fisher, go talk to so-and-so.'" Over time, such informal "Sneakernet" tips were codified into notes that were saved and circulated. As Stifel emphasized, "We were making this up as we went along and getting information shared was very important. So a lot of those memos were just our way of communicating, 'Here's a little quirk that hasn't been documented.'"[37] Programmers thus began producing documents themselves. By March 1982, the Applications Software documentation library included internally produced materials like "How to Keep Moving Objects from Crashing Into Background Unless You Want Them To" and an explanation of the hand controller ports (figure 6.1).[38]

While informal mentorship remained the norm, beginning in January 1982 programmers also began organizing seminars. Urbaniec emphasized that these provided an opportunity "to actually stand up and make presentations—get people to get up out of their cubicle and learn something new." Not counting general orientation or question-and-answer sessions, at least 117 distinct seminars were held, falling roughly into three categories. First, there were occasional topical seminars (for instance, "CES: the Untold Story," where programmers who attended the Consumer Electronics Show (CES) described their experiences).[39] Second were "game evaluation seminars" for work in progress (for instance, "*World Series Baseball* Software Support Group" and "*Pinball* Software Support Group").[40] Third and most frequently, there were "programming seminars" providing technical knowledge. Some were "training seminars" or "orientation seminars" for new hires, including one coordinated curriculum of seventeen seminars. Many seminars had humorous titles reflecting the playful environment of Applications Software, including "Assembly Instructions Made Human," "Fancy-Smancy Title Screens," and "Return to the Planet of the Moving Objects."[41]

Inside the office, the ludic atmosphere was coupled with more formal management systems—reflecting how videogame software encodes fun but requires structure. For example, Group Leaders provided regular updates regarding videogames in their groups.[42] One "project progress" memorandum from Haft to Baum detailed work on nine videogames, listing the programmer, size, "confidence level" on the game's progress, and deadline for expected completion.[43] More formally, Daglow recalled that Baum's

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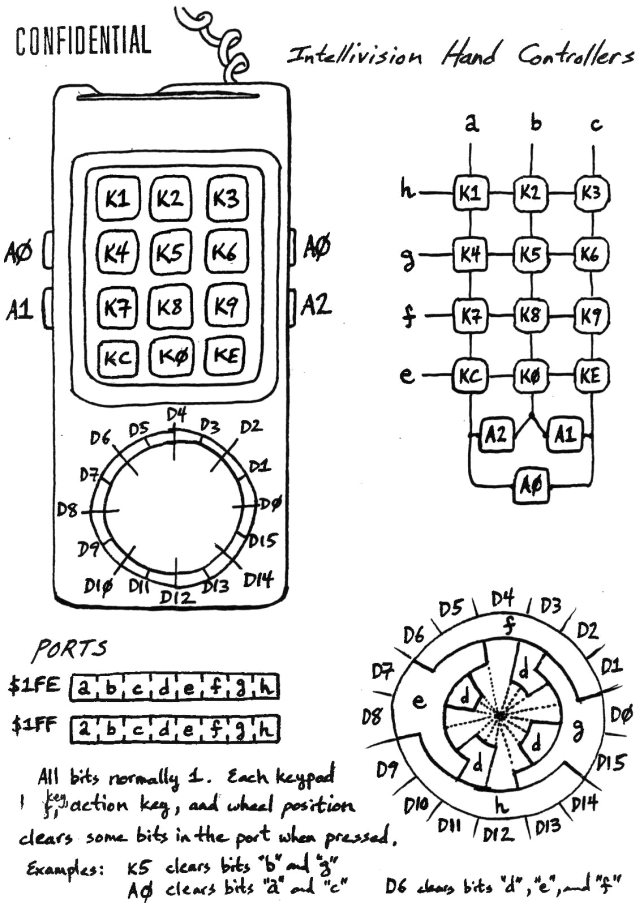

6.1 Hand-drawn explanation of the hand controller inputs and ports (by Bob Newstadt).

"management style was to have regular meetings. We had the Goldenrod meeting, which was a standard." These weekly meetings were organized around yellow charts called "Goldenrods" that showed a videogame's start date and size and tracked three important timelines: "Applications Software" (the programming schedule), "Graphics" (referring to the packaging and instruction manual), and "Manufacturing." This reveals a tripartite framework for Intellivision game production. At Goldenrod meetings, some videogames would be presented as "storyboards," and games further in development would be demoed. Through this oversight, managers ensured videogames were completed on schedule, and sometimes decided if work on a game should cease.

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While managerial structure was needed, Baum emphasized that "I was there to be protection for the teams underneath me, so they were not besieged by management." This protection allowed playful creativity to thrive. However, Baum also had to arrange more meddlesome product review meetings.[44] These meetings involved the President and the Senior Vice-Presidents of Production and Marketing moving from cubicle to cubicle, with programmers allotted ten minutes to present their videogames.[45] Such meetings were usually viewed as intrusive, as captured by Creative Media staff Brad Geagley's satirical "Dante's Infernal Guide to Applications Software," consisting of short statements accompanied by images from Dante's *Inferno* (figure 6.2). As executives examined games in progress, Daglow recalled that "some were pleasant and made reasonable comments. Others were petty and dictatorial ('That background ought to be blue. Change it.'). I spent a great deal of time talking my best designers out of quitting after being the targets of such visits."[46]

Brainstorming Videogames

Brainstorming was another playful aspect of working at both Mattel Electronics and APh. Mattel was no stranger to creative brainstorming. Its success as a toy company was predicated on intensive innovation, with entire departments like Preliminary Design dedicated to generating new ideas. Mattel Electronics' brainstorming sessions took place in offices, parks, and often a private room at Barnabey's Hotel and Restaurant in Manhattan Beach. Urbaniec recalled "eating and having a beer or a glass of wine or whatever. We'd really start to loosen up and new ideas would come out." In an announcement for a "Blue Sky Session" in July 1981, Chang set forth several ground rules, including, "Do not be too quick to reject a half-baked idea," "Break from the past . . . sort out the technical problems later," and "If you already have a good idea today, do have it properly documented now."[47]

While APh did not have an institutional history with Mattel, creativity was part of the job. Initially, APh was asked to create sports titles or traditional games like blackjack, poker, and horse racing—videogame ideas where the source material was ready for simulation. Other early titles, like *Space Battle*, evolved from design documents originating at Mattel. However, APh did originate ideas, like *Star Strike* (which drew from the Death Star attack scene in *Star Wars*). Loughry recalled early visits to Mattel Electronics with Hightower, where Chang "was the person in charge, and we'd present the different games. And then they would tell

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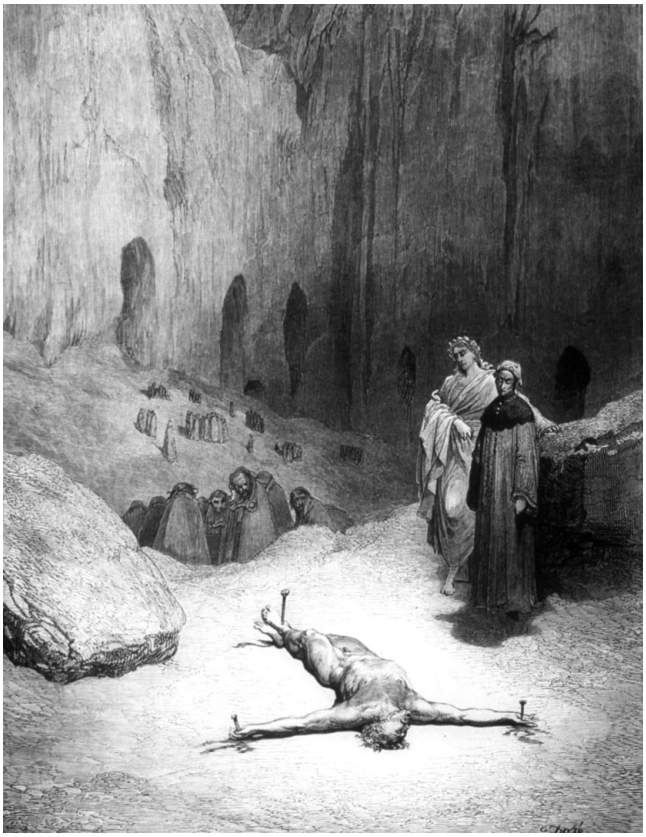

IT MAY BECOME NECESSARY TO RESTRICT THE
THE PROGRAMMER TO THE PROJECT AS DESIGNED
AND NOT LET HIM/HER VEER FROM THE APPROVED
FORMAT.

6.2 Image from the humorous memorandum "Dante's Infernal Guide to Applications Software" (Brad Geagley, Blue Sky Rangers archive). Geagley chose Gustave Doré's 1857 illustration of Caiaphas from Dante's *Inferno* to accompany the text.

us which ones they wanted us to actually do." David Rolfe recalled Loughry maintaining a notebook with videogame ideas. Loughry also created one-paragraph descriptions of cartridges in development. One such summary from June 1981 listed eleven videogames, including *Sub Hunt, Star Strike*, and *Frog Bog* (figure 6.3).[48]

Once Mattel Electronics hired its own team of Intellivision programmers, they generated ideas individually, through brainstorming sessions, and via competitions. Some sessions were general while others were specialized,

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Tom Loughry | APh Technological Consulting | 6/30/81

PRELIMINARY CARTRIDGE DESCRIPTIONS

SUB HUNT - 4K Cartridge 1 player.

This is a game of open-sea danger and action. You command your submarine in attacking enemy convoys - sinking ships and avoiding their guns and depth charges. You control rudder, speed, and depth as well as your deck gun and torpedoes. Line up your prey in your periscope and do your worst!

TRENCH GAME - 4K Cartridge (Possible Star Wars license) 1 player.

Save your planet from the dreaded Death Mar (a planet-killing space station) by your skillful fighter piloting. Fly down into the trench, shoot enemy fighters and avoid their gunfire as you seek to destroy the Death Mar. Space Action Game.

FROG GAME - 4K Cartridge 1 or 2 players.

This is a fairly simple children's game. You control your frog, trying to jump from your lilly pad and catch flies. Easy game play and good graphics make this especially relaxing. Compete with someone else or relax by yourself, catching flies and hopping around.

CARDS - 4K Cartridge 1 player

For those who like to play cards or want that kind of relaxion, this cartridge provides several of the most popular card games. Play one to three computer controlled opponents in games of Crazy Eights, 7-card Rummy, Gin Rummy, a variety of 500 Rummy, or Hearts. The computer does all bookkeeping while you enjoy the game!

EMPIRE - 4K Cartridge 1 or 2 players

This is a game of empire building and territorial expansion. You create cities, build roads, wage wars, and build up your empire in your attempt to conquer your opponent. Strategy is the key as you wage your struggle in real time, either against the computer or against a friend.

REVERSI - 4K Cartridge 1 or 2 players

Othello is a variant of Reversi (invented in the 1880s). This cartridge has the standard Reversi game as well as a few other interesting variants. Strategy and skill can be developed in any of several difficulty levels against the computer; or you can play a friend.

ADVENTURE - 4K Cartridge 1 player

Here is adventure and excitement as you explore the underground caves. Who knows what awaits you as you venture into the unknown. Deal with monsters and use objects you find along your way.

PRELIMINARY

6.3 Videogame summaries (Tom Loughry, "Preliminary Cartridge Descriptions," June 30, 1981, Tom Loughry archive).

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including one for educational cartridges (with ideas like "how weather works" and "building various inventions" like a clock, plane, and nuclear power plant).[49] Sometimes programmers conducted on-the-spot ranking of brainstormed ideas. For one such session, the top-ranked proposal was Connie Goldman's "Heaven Sent." This game was to revolve around Gabrielle, "the littlest angel," whose "mission is to climb to the gates of heaven" while avoiding devils throwing pitchforks and brimstone.[50] More formal competitions were held as well. In addition to a competition for *Kool-Aid Man* (chapter 7), a competition was held for a magic-themed title. Ideas also emerged through a slower, iterative process. For example, Warhol wrote a memo proposing what became *Mind Strike*: "I would like to start spending my time developing a strategy game. It's based on an idea I had many years ago and can be best described as a cross between checkers, chess, and Stratego."[51]

On occasion even executives would propose videogames, for example, about the *Rocky Horror Picture Show* or the 1985 return of Halley's Comet.[52] Such suggestions were not pursued, but marketing staff played a more significant role in brainstorming new games. Frank O'Connell, Senior Vice President for Marketing, referred to this as a "front-end strategy" that would begin by "defining how many games we want in what category." This is another way in which videogame development inherited frameworks from Preliminary Design, where for toys, "marketing represent[ed] both the beginning and the end of the new product cycle."[53] The marketer Mike Doepke concurred, "the research was being done as to what was selling in the marketplace. We would feed that back to the programming group." Indeed, marketers sometimes participated in brainstorming sessions with programmers. When announcing one such session, Chang's first ground rule was, "Everyone speaks as equals, including marketing people."[54]

Collaboration in Videogame Design

Many early Intellivision games had one primary author who, as Loughry put it, "wrote the manual for goodness sake, as well as doing all the graphics and the sounds and the coding and the design." Hoshizaki emphasized how as a result, "it wasn't just putting a tiny bit of something into the project. It was our project and we were responsible." Stifel noted a mentality of "one programmer, one game. One programmer did it all. Graphics, sound, design, programming, everything. You're going to program the game, you're going to design the game, you're going to invent this game."

While sole authorship was an important element of early game design, Intellivision game design frequently involved collaboration, complicating narratives of the "one-person-one-game system" commonly described in

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videogames history.[55] Even early Intellivision titles involved more collaboration than is often recognized: Dave James's "Battlestar Galactica" concept, worked on by Mattel employee Bob Del Principe, was developed into *Space Battle* by APh programmer Hal Finney with assistance from Glenn Hightower (chapter 2). Working with someone else's concept or graphics was common. For instance, when Smith was programming *NBA Basketball* at APh, James provided the screen layout and basketball court art. Smith was surprised that the scoring area occupied the upper half of the screen: "Only like 30% of the screen was being used for the gameplay. It was the vision they had of what Intellivision was going to look like." APh programmers could also request graphics. Loughry recalled looking through the graphics needed for a videogame, and for "the things that I could not do, I had somebody that I could contact at Mattel."

In Applications Software, a game might be passed to other programmers because the original programmer was experiencing difficulties, was needed for another title, or had left the company. *B-17 Bomber*, mentioned in the Introduction, was first developed by Sohl, with input from Del Principe. Kai Tran and Peggi Decarli helped Sohl develop the graphics. Due to difficulties completing the videogame, Fisher and Roney were brought on to help.[56] Sohl worked in the evenings, with Fisher and Roney working on different parts of the code during the day. Even in this early period, it was becoming apparent that such collaboration unlocked creative possibilities. In one brainstorming session after *B-17 Bomber*'s completion, concern was expressed that "colossal games" with multiple authors were difficult to manage, but Fisher responded that such videogames could "take advantage of team, versus singular, programming."[57]

Over time, specialization emerged in Applications Software through everyday collaboration, aided by the emergence of focused design tools (chapter 5). Specialists usually continued to program their own titles while contributing to other videogames, but by 1982, the programmer Eric Wels noted that about four additional staff members had been hired solely as graphic designers. In December 1982 Andy Sells accepted "the responsibility of coordinating music/sound effects" and "lining up a sound specialist for your game as well as supervising and troubleshooting the aural effort."[58] By May 1983, a draft list of cartridges assigned to "graphic designers, sound specialists and educational product specialists" showed, for instance, that among other assignments Joe Ferreira (later King) was given graphics duties for *Motocross* and *Mind Strike*, Goldman was assigned *Vectron* and *Scooby Doo*, and Sells was tasked with sound design for *Mission X* and *Maze-A-Tron*.[59] Haft, the designer for *Maze-A-Tron*, recalled how in addition to Sells's sound work, Wels did the graphics: "We had fun. It was an opportunity to work

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with other people because it can get really boring just being in a cubicle by yourself." The emergence of collaboration fostered labor specialization but also extended playful modes of interaction and game design.

Less explicit forms of collaboration occurred as well, like when marketers helped brainstorm videogame ideas. During the development process, marketers could be hands-off. Doepke emphasized that "game development was pretty much determined within the programming group and marketing just signed off on it." However, other marketers suggested that marketing could play a more collaborative role. Lockton emphasized that marketers were familiar with videogames and frequently contributed ideas to product design and development. Likewise, Gillis emphasized the "very important interaction between marketing and the actual software developers in terms of how the games themselves were executed," recalling that when Mattel Electronics needed more space videogames, marketing worked closely "with the programmers to even determine how explosions should be on screen."

We call these suggestions "marketing mechanics." Game mechanics are broadly understood as the rules, procedures, and actions that define play in a particular game. We speak of marketing mechanics when gameplay dynamics are shaped by marketer requests or, even more fundamentally, market share. For example, in chapter 9 we discuss how marketing mandated that titles for the Intellivoice extension be unplayable without its voice feature, leading to instances where players had to remember spoken numbers, then enter them to progress. For videogames designed for the Entertainment Computer System, discussed in chapter 10, programmers had to add gameplay features that would allow players to change or manipulate a game—like designing their own levels. Programmers sometimes found suggestions and contributions from marketing staff intrusive, recalling earlier efforts by Preliminary Design toy designers to keep marketers at arm's length. Geagley's satirical memo, mentioned previously, included the quip "You will learn that Marketing has the final say on what products you will assist in developing."[60]

Creating manuals also involved collaboration. Scholarship on Atari games has concluded that they "were truly a 'pick up and play' experience. Little documentation was required for a user to understand and enjoy simplistic games such as *Asteroids* or *Space Invaders*."[61] In contrast, many Intellivision titles were nearly unplayable without their manuals, reflecting the influence of board games and the aesthetics of intelligence and sophistication distinguishing Intellivision from its rival. This included not just the crucial early sports titles like *Major League Baseball* and *NFL Football* but strategy games like *Utopia*. *Utopia*'s overlays show icons for the keypad numbers 1 through 0, including a red cross for 5 and a black rook for 1 (see figure 2.9). Only from the manual could one learn that the red cross is a hospital costing

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75 points, which "greatly increases factory production," and the black rook is a fort costing 50 points, which "guards surrounding land area against rebels."

Programmers usually drafted their own manuals, sharing them among colleagues before sending them for editing and production to Visual Design, a longstanding Mattel division. For instance, Tom Loughry circulated an eight-page handwritten "gameplay and instructions" for *Boxing*, followed three months later by a memo detailing changes to the game.[62] William Fisher noted in the *Space Hawk* code, "10/12/81 . . . Prepared an early version of the instructions for the writers to see."[63] Final versions of a manual sometimes retained programmers' original prose: the phrase "Strategy should be a mixture of offense and defense and common sense" in Loughry's draft for *Boxing* appears in the final manual as "Strategy should be a mix of offense and defense, plus common sense."

These emergent forms of collaboration shaped labor practices and videogame design, and increasingly became an explicit topic of discussion at Applications Software. Asserting that "our current design methods are haphazard, unprofessional, and unreliable," in July 1983 four programmers circulated a memo proposing "a new game design process."[64] Bob Newstadt, one of the authors, recalled "being really surprised when I went to Mattel. I was very excited to learn how to do videogames. So I went around, 'Oh, how do you make it?' And everyone had a different story." Newstadt added that by mid-1983 the programmers had "talked about the commonalities of it. Our main goal is we thought the games would be better if it wasn't just the heroic work of one person."

Examining Mattel Electronics' production culture involves "turning the attention to game industry professionals' everyday practices," as Olli Sotamaa has emphasized.[65] Sotamaa located this approach within "studio studies, a subset of game production studies that puts focus on individual studios," phrasing that reflects cinematic metaphors structuring contemporary videogame design.[66] Intellivision, however, illuminates a prehistory of studio studies. The language of game "studios" was unknown during the second generation. The idea of publicly crediting individuals was contested, and design was analogized to computer programming, not moviemaking. The practices through which staff at APh and Applications Software staff made Intellivision games provide an archaeology of studio studies, including APh's status as a proto-independent studio and Applications Software's status as a proto-studio within a larger company. Through collaborative practices, programmers, managers, and marketers developed videogame code and tools, texts and reports, office layouts and physical devices, and social norms and conventions. These constituted Intellivision's production culture, the legacies of which inform the world of videogame production today.

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Constraints, Trade-Offs, and Affordances

7

> Human activity must impose limits upon itself. The more art is controlled, limited, worked over, the more it is free. . . . The more constraints one imposes, the more one frees one's self of the chains that shackle the spirit.
>
> —Igor Stravinsky, *Poetics of Music in the Form of Six Lessons* (63–65)

What insight lies in this seemingly paradoxical statement that constraint frees the creative spirit? We often shared Stravinsky's words with programmers, who found it reflected their experiences. In interviews, archival documents, even code, we encountered constraint experienced as enabling. Consider haiku, a Japanese genre of short poetry, typically with three lines in a 5–7–5 syllable structure. We sometimes referred to "haiku" videogame design when encountering constraint in archives and interviews. Analogous to haiku, the programmer Julie Hoshizaki noted how constraint led to "simple ideas for the games. It didn't have to be so many of these complicated, deep ideas. The game could still be fun." Constraints were productive both by limiting overwhelming design choices and by motivating creative ways to surpass them. When announcing an award for the programmer and graphic designer Connie Goldman in May 1983, the manager Don Daglow observed, "Many times what are believed to be limitations of the machine turn out to have been human limitations when an individual comes along who surmounts them."[1]

A broad literature in play and design has explored how creativity involves "embracing the particularity of a form and working within its

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boundaries."[2] In an analysis of limits and constraint, one of the founders of platform studies, Ian Bogost, suggested that "limits are made from materials."[3] Even when speaking of poetic form as we do earlier, Bogost framed it as a material constraint. Materiality often acted as a constraint for Intellivision, from cartridge memory to the workings of television sets, from videogame code to hardware chips. However, recalling Nathan Altice's warning against presuming materiality provides "the base, as well as the temporal precedence, for all subsequent layers," we argue that other forms of constraint—particularly those linked to time, licensing, and marketing—intersect with material constraint.[4]

Constraints and Affordance Zones

We explore productive constraints through "affordances," designed elements of an environment that shape possible action. The concept originated in the work of the psychologist James Gibson, who understood affordances in terms of relationships between perceivers and the world. A sufficiently strong, flat surface can act as a chair, but the surface must be the right height, and "knee-high for a child is not the same as knee-high for an adult, so the affordance is relative to the size of the individual."[5] A book can be a source of knowledge, a gift, or means to kill a mosquito.[6] There are also "social affordances" that emerge in relation to material or technical affordances. For instance, the telephone reshaped social conversation—which afforded new ideas of distance—and antibiotics reshaped norms for healthcare practices.[7]

The concept of affordances has appeared in a range of work on digital culture, including gaming, social network sites, listservs, and YouTube.[8] We place this notion of affordances into conversation with the concept of medium specificity, which implies that specific features define a medium for artistic expression. For example, paintings have attributes like "the flat surface, the shape of the support, the properties of the pigment."[9] One defining feature of modern art has been highlighting medium specificities. Thus, art movements like abstraction and Cubism developed techniques to emphasize the flatness of the canvas. Technical platforms like videogame systems contain medium specificities, or more accurately, platform specificities. For example, Intellivision only allows for a certain number of colors, and these are further limited for moving objects. Videogames were shaped by these "enabling impediments."[10] In general, systems with platform specificities become "ludic mediums" that programmers play within and explore.[11] As the Intellivision programmer Tom Loughry noted, the challenge was "what can we make this machine do? How can we twist it and make it dance on its head?" While programmers often sought to transcend a machine's

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constraints, they also sought to hide them, like painters using techniques to produce an illusion of depth. This is also a part of the ludic exploration of platform specificies.

Linking notions of affordance and medium specificity provides a conceptual framework for constraint that avoids assuming that technology determines society ("determinism") or society determines technology ("constructivism"). Analogous to scholarship showing that medium specificity is shaped by social rules and not the "brute positivism" of "physical substance," we assert that the relationship between technology and society takes the form of historically specific spaces of practice where the social and technical are mutually informing—what we term "affordance zones."[12] This concept highlights how productive constraints, both social and technical, shaped videogame design in ways that included but also surpassed limitations. Constraints might first appear restrictive, but when working around, within, and through them, they become productive, transforming into zones of potential action.

All platform cultures express intersections of constraints. Yet elements of Intellivision's platform culture, including computational elements like the EXEC operating system and Mattel's preeminence in marketing and focus on strict development schedules, bring these constraints and their intersections into sharp relief. Thus, we focus on how affordance zones emerged in Intellivision game design, including the salience of trade-offs as one framework that Intellivision game designers used to conceptualize the relationality of affordance zones.

Computation as Affordance

One way to think about affordance zones is in terms of genre. Just as haiku is a poetic genre, "Intellivision programming" can be considered a computational genre. Constraints like Intellivision's STIC graphics processor supporting only eight moving objects or a strictly defined background grid (figure 2.7) are analogous to the 5–7–5 constraints of haiku, shaping the aesthetic form of Intellivision games. For example, how do you portray a strike in bowling when there are ten pins and a ball but the STIC only allows eight moving objects? Programmers Rick Levine and Mike Minkoff encountered this limitation while programming *PBA Bowling*. Levine explained, "One or two of those bowling pins are actually background graphics rather than sprites [moving objects]. We played tricks to make it look like they were sprites." If you watch a strike closely, the front pins start moving, hitting other pins, but in the back you can sometimes see a pin jump from one static card position in the background grid to one row above it without an animating

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movement—as if sliding off the back of the lane. Moreover, a pin hit early on will tumble to the side and disappear, freeing up a moving object for another pin.

The strike created an affordance zone, where constraints mingled with afforded possibilities. Since moving objects "move," they afforded the possibility of moving where they were no longer needed and could thereby disappear and be reused. Additionally, background graphics afforded the possibility of looking like a moving object, even though they were not. Many Intellivision programmers used such tricks, creatively manipulating moving objects to overcome limitations like depicting a sports teams with more than eight players on the field. Another computational constraint is that collision detection, often handled by the STIC, could miss objects moving too quickly when the screen is updated.[13] With this in mind, John Sohl programmed *Astrosmash* bullets to lengthen as play sped up, increasing their surface area as falling rocks fell faster.

The programmer William Fisher noted that the STIC also "would not allow you to write to its registers when it was busy generating a video signal. It meant that you literally were forever blocked from reusing the sprites down the screen." Unlike Atari, which allowed programmers to draw graphics on the fly and reuse moving objects through various techniques, Fisher emphasized that "we had to live within the constraints of the beam." Intellivision programmers could not reuse a moving object horizontally or vertically, thus displaying it twice or more on a single, drawn frame. However, like their Atari counterparts, Intellivision programmers could reuse a moving object using a trick called "multiplexing"—changing a moving object's position in different frames to create the illusion of more moving objects on the screen. As the STIC displays the image sixty times a second, if you shift a moving object's position every other frame, there can appear to be two objects onscreen. The first object is drawn on the even frames at one location while the second is drawn on the odd frames at a different location. Instead of drawing one object sixty times a second, two objects are drawn thirty times a second. However, this trick was forbidden at Mattel Electronics, exemplifying how computational and cultural constraints intersected.

Since each object is drawn only every other frame, the downside of multiplexing is "flicker." This downside was not unique to Intellivision. It famously occurred in Atari's *Pac-Man*, where one moving object produces all four ghosts, each of which flickers significantly because they are drawn only 25 percent of the time.[14] Banning flicker maintained Intellivision's high graphic standards and demonstrated its superiority to Atari.[15] Because of Intellivision's moving object limit, the inability to reuse moving objects within the same frame, and Mattel Electronics' ban on multiplexing, programmers turned to other techniques to create games filled with movement. For

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example, in *Space Armada* and *Worm Whomper*, these constraints are overcome with GRAM sequencing (chapter 3). This technique animated background graphics cards to create the effect of far more than eight moving enemies.

While programmers could surmount Intellivision's technical limits, design often worked creatively within them. For example, the eight moving objects limit shaped gameplay since players could often identify them, even using this knowledge strategically. Because *Utopia* has two pirate ships, two cursors, and two schools of fish, there can be only two weather events at any time (rain, storms, or hurricanes). While never mentioned in the manual, savvy players know that if one weather event disappears offscreen, one (and only one) will soon replace it. In *Astrosmash*, the player's ship can fire two bullets at once, for a total of three moving objects. As a result, players know a falling rock will explode and disappear rather than split in two if there are already five rocks onscreen.

Working within constraints could be frustrating but also inspiring. While Intellivision's background was composed of 240 tiles arranged in a twelve-row by twenty-column grid, at most sixty-four unique programmer-created graphics cards could be used in this grid when no cards were used for moving objects (chapter 2). The remaining cards had to either be repetitions of those sixty-four cards or taken from Intellivision's onboard graphics library. When programming the detailed opening screens for *Thunder Castle*, Goldman recalled being "so limited in the number of tiles that you can have. I just remember feeling constrained because I wanted to put so much more into the pictures, but I couldn't." Later in her career, Goldman was able to use more advanced graphics tools like Photoshop. She emphasized, "It was amazing, but I missed having all those limitations too. Just because it was a much bigger challenge." Dave Warhol, who continued to work with Goldman, recalled her saying "I want my pixels back!" The programmer Karen Nugent shared this sentiment: "I would rather design that way, because it's more limited and you have to really think where each pixel goes."

Limited memory was one of the most consequential constraints faced by programmers developing for all platforms at this time. Both ROM (Read-Only Memory) and RAM (reusable Random Access Memory) were costly and in short supply. For example, Intellivision cartridges were originally 4KD of ROM and later became 8KD or 12KD.[16] Larger ROMs existed but not at an acceptable price point given Mattel's relentless cost engineering. In comparison, by the 2020s smartphone memory capacity was commonly 512GB (about 512 billion bytes), equivalent to about 100 million Intellivision 4KD cartridges.

Cartridge space thus emerged from an intersection of technical and economic constraint, a familiar intersection at Mattel. For instance, the Teach

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& Learn Computer developed by Mattel Toys used interchangeable discs to allow short audio responses when using a simple interface. Bob Knetzger, a designer in Preliminary Design, recalled how Keith Hiply designed a system for the Teach & Learn Computer where a simple microprocessor would drop a needle at the precise time to trigger the correct sound based on which interface button was pushed. Knetzger emphasized, "That was the clever, cheap way to make that work. It was like designing with a rubber band and a popsicle stick. That's what was so cool about Mattel and the toy industry. With enough money anybody can do it. But what can you do on time, for very low cost?"

Programmers were constantly cutting and optimizing code while seeking creative solutions to fit their videogames within limited cartridge space. Because development systems could execute code beyond the cartridge limit, Loughry emphasized how "even when you got the game mainly working, it usually was too big to fit in the cartridge. And so now you're poring through your code trying to find ways to compress it." Often this took the form of "cutting decles"—a mantra used by Mattel Electronics programmers signifying the removal of 10-bit instruction codes from the program to save space. We see this imperative in Fisher's *Space Hawk* code: "10/14/81: Save decles! Program size reduced successfully. 10/20/81: Saved 25 decles in KEYPAD. 10/22/81: Implemented the last code for rainbow bubbles, cutting decles everywhere to make it fit."

Gabriel Baum, Vice President of Applications Software, explained in a memo to management that "our normal procedure is to program to excess and then cut the size."[17] Mattel Electronics developed a set of normative practices around videogame design that prioritized creativity, saving the practicality of cartridge constraint for a later stage. This reflected Mattel's history of innovation, where Preliminary Design members pursued toy ideas with less regard for practicality. Responding to computational constraints such as cartridge space constituted an affordance zone, navigated collectively through memos, seminars, documentation, informal discussions, and playful challenges where programmers tried to achieve a goal with the least amount of decles.[18]

Saving space opened possibilities for new design features, while underscoring trade-offs. As Loughry noted, "Every game, at the time it was done, was packed to the gills. When you wanted to add a feature or fix a bug, you had to pack out decles so that you could actually do the fix." For example, in a 1982 memo to APh, Daglow provided a hand-drawn image for *Advanced Dungeons & Dragons: Treasures of Tarmin*'s title screen requesting a change, adding "please advise on what game changes had to be made to free the space."[19] Loughry, who programmed the game, observed that this cartridge was 8KD, but since the title text required 117 decles, a little more than 1 percent of that space, decles (and maybe gameplay) would have to be cut to accommodate the

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change.[20] Fisher emphasized that programmers "reached a point on almost every product where in order to add a feature, you had to delete something." For *B-17 Bomber*, Sohl created an altimeter that took up a few hundred decles for custom rolling digits. Fisher recalled, "We looked at it and said, 'That's really cool. How much space does that take?' It was out."

While platform studies scholars often focus on surprising and creative tricks to counter technical constraint, more mundane (but no less creative) deliberations surrounding trade-offs were often a more pervasive response. Loughry emphasized, "I was pushing the limitations of the machine, and anytime you're doing that, you have to be really sensitive to the trade-offs that you're going to have to make." What is gained and what is lost when encountering a limitation, working within it, or trying to surpass it? Programmers often tarried with such trade-offs, just as a poet knows that adding a two-syllable word in the middle line of a haiku with seven syllables requires cutting two syllables in the same line. This was not just an experience for programmers. Bill Gillis, Vice President of Marketing, explained that marketers and programmers would meet to decide "what trade-offs we wanted to make because of the restrictions of the technology, the chip sizes."

Thinking in terms of trade-offs is common to programming platforms, each with their own particular architectures. But several trade-offs were built into Intellivision's computational infrastructure. The STIC supports enlarging moving objects at the cost of resolution, or different display modes at the cost of available colors. The EXEC operating system facilitates game design at the cost of game speed (chapter 5). Using more programmer-defined graphics RAM for moving objects means less for background cards. Tricks to overcome constraint might be thrilling, but Intellivision programmers commonly thought in terms of navigating constraint through trade-offs.

Beyond computational constraints, Intellivision programmers also encountered computational affordances that intersected with other technologies and even social histories. For example, constraints appeared in relation to the television. When Ray Kaestner converted the arcade game *BurgerTime* to Intellivision, this required a translation between a portrait orientation to the landscape orientation of television. Kaestner not only redesigned levels but made the lettuce disappear when stacking burgers at the bottom of the screen. Another example of constraints linked to television was TV POWWW!. Developed by Marvin A. (Marv) Kempner for the Fairchild Channel F and then Intellivision, TV POWWW! allowed television viewers to call into the show and play a videogame by saying "pow!" to trigger an action, like firing a gun or kicking a ball.[21] Intellivision cartridges like *Space Battle* and *Major League Baseball* had to be reprogrammed and simplified for TV POWWW!, which imposed two constraints on videogame design. First, in place of the complex

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hand controller, gameplay was reduced to the verbal equivalent of pressing a button. Second, due to insertion within the show's programming, gameplay could take no longer than thirty seconds.[22]

In terms of social histories as affordance zones, programmers often spoke of "inheriting" code from earlier videogames, which acted as loose constraints. For example, *Space Hawk* was developed from the code for *Astrosmash*. As Fisher explained, the former modified the latter's code for scoring and to adjust the speed of moving objects. *Space Hawk* code contained the original *Astrosmash* code below for reference, but Fisher created a similar database, modifying values to store speed tables appropriate for *Space Hawk*:

```
speedrck::    decle 16,18,20,22,24,27,30,33,36,38
              decle 40,42,44,46,48,50,52,54,56,58
              ;old (ASTROSMASH) maximum speed of rock
```

The most widespread example of inherited code was the Killer Tomatoes program new hires used to learn Intellivision programming at Mattel Electronics (chapter 5). Programmers would tweak Killer Tomatoes to create their own games. Fisher emphasized "a large proportion of the games written at Mattel probably still have vestiges of the source code for Killer Tomatoes." For instance, a comment in the *Pinball* code indicates that the main program (PMAIN) was partially "rewritten from killer on Oct 5 1982."

Color as Affordance

Intellivision color was a computational affordance that demonstrates how social and technical practices gathered around constraints to transform them into productive affordance zones. The use of color in Intellivision programming is limited and relatively straightforward. Intellivision supports only sixteen colors: eight primary colors (black, blue, red, tan, dark green, green, yellow, and white) and eight pastel colors (gray, cyan, orange, brown, magenta, light blue, yellow-green, and purple). The pastels are not just paler shades of primary colors; they include key colors like purple and orange. In Intellivision programming, the primary colors are defined using 0–7 and the pastels using 8–15. Thus, the primary colors are easily accessible by 3 bits (sufficient to encode eight possibilities) while pastel colors require 4 bits. Save for some special tricks discussed later, Intellivision colors were not programmable, and designers could not manipulate the palette beyond the built-in possibilities.

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Aside from sound, Intellivision games are ultimately color data output to a display. The STIC outputs 5 bits for each pixel to Intellivision's color processing chip, the AY-3-8915. The first 4 bits encode the color selection of individual pixels, and the last bit is used to flag special output situations important for televisions like blanking, sync, and colorburst. The AY-3-8915 uses an "external resistor network" to perform digital-to-analog conversions, using the bits for each pixel to produce predefined waveforms sent to a radio-frequency modulator and ultimately to the television set.[23]

Stephen Maine and Eric Berman, both from General Instrument (GI), developed the AY-3-8915. Implementing the color processor was not an easy task. GI engineers had developed an add-on color chip for their first-generation Tank videogame, and the STIC extended this work. "It was a bigger challenge than you think making a good digital image using an analog television," said Maine, "it was a real nightmare." Berman explained that "certain transitions from one color to the other would be perfect, a nice sharp transition. But if you go from red to green, there's a black bar in the middle of it." Maine worked diligently to understand how the National Television Systems Committee (NTSC) color signal worked in order to reproduce particular colors consistently—a difficult task, and indeed, NTSC was jokingly referred to as "Never The Same Color twice."

Why only sixteen colors? Beyond the difficulty of triggering particular colors through digital manipulation of the television, the STIC was a complex chip with room for only four video output pins, allowing sixteen different color selections. Adding more pins to encode more color options would have required a larger chip, which was not cost-effective. Additionally, Maine emphasized that more colors did not seem to "add anything to the range of potential games or gameplay."[24] GI engineers thought sixteen colors "would be enough," Berman said, given that it was "twice the number of moving objects." Maine explained that they considered creating a "mechanism that allowed having a range of 16 color palettes that would reside on the color chip that could be selected," but, as Berman said, "we just didn't have time to put the engineering into it."[25] Moreover, much of GI's previous videogame experience had been with black-and-white game chips, like the AY-3-8500 *Pong* clone. Though GI produced colorizing chips for some of these games, their thoughts about color were constrained. Duncan Harrower, who designed the AY-3-8500, noted that "we probably should have allowed more colors to be defined [for Intellivision] than the ones we ended up with." When asked why, Harrower joked, "Not enough gin and whiskey. Remember, I had just done a black-and-white ball-and-paddle game . . . so having 16 colors seemed a blinking luxury to me." Thus, Intellivision colors were constrained

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by multiple technological, historical, and social factors, including chip pin limitations, GI's history with television games, the difficulty of manipulating television colors, and de-emphasizing color as an element of game design.

While the technical constraint of sixteen colors was limiting, so too were the chosen colors. Color adjustments continued at Mattel after GI completed the color chip's circuitry. Engineer Brian Dougherty's first Intellivision project in 1979 was trying to improve the output to make "better, richer colors." Dougherty recalled that "I guess the marketing folks at Mattel felt, 'Well that red's not really good enough' and 'that green's not the right shade of green.'" To tweak the AY-3-8915 palette, Dougherty had to adjust four different values used "to shape the color frequency wave that the circuitry was putting out," drive to an electronics store to burn a programmable ROM chip, and return to Mattel to confirm improvement. Even the final established colors became their own source of frustration. Fisher recalled how "five of them were variations of brown or green, which is really horrible. So, you've got yellow-green, brown (which is greenish depending on your television set), tan, dark green, and green." Fisher added that the magenta color "was this horrible hideous color that you almost never wanted to use."

Color was further constrained by the STIC's distinct background modes. Each mode carried different trade-offs concerning color. In Foreground-Background mode, a graphics card is encoded with one color for the background and one color for the foreground pixel pattern in the card. The foreground pixel color is encoded using only 3 bits, meaning that the color can only be selected from the eight primary colors (0–7), not the pastel colors (8–15). Yet all sixteen colors are available for the background color of the card since it is defined by 4 bits. In contrast, in Color Stack Mode programmers can use all sixteen colors for the foreground pixels. However, this versatility comes with its own trade-offs. The STIC selects the background pixel color for a card from a memory stack located in the STIC registers. This memory stack contains four locations that can each encode one of Intellivision's sixteen colors. The stack can be advanced to the next color in memory, rotating to the first entry after advancing past the fourth. Thus, in Color Stack Mode the background pixel color of cards is constrained. Each card cannot have its own individually defined background color: it must rely on the stack.

The moving object constraint also intersected with color constraints because Intellivision's eight moving objects could only be one color. Programmers could appear to exceed this constraint by layering moving objects together. Arcade *BurgerTime*'s chef has white clothes and orange skin, which Kaestner preserved in the Intellivision conversion by using two moving objects. However, for cultural fidelity, the egg also had to incorporate two moving objects, one for its white body and another for its yellow yolk. This has

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interesting consequences for the Intellivision version. At higher levels, four hotdog enemies (four moving objects), one egg (two moving objects), and the chef (two moving objects) can simultaneously be onscreen. But what about the chef's pepper spray that temporarily disables enemies—a potential ninth moving object? Kaestner solved this problem by temporarily transforming the yolk moving object into a pepper image and moving it in front of the chef. Thus, the egg yolk briefly disappears when using the pepper.

Over time, programmers forged creative responses to Intellivision's color constraints. Some programmers became known as skilled in color, including Goldman, Nugent, Joe Ferreira (later King), and Eric Wels. In chapter 5 we discussed how Wels created a development tool, "Mr. Color," which allowed programmers to experiment more easily with colors. Programmers also held seminars to share best practices, with titles like "Colors: What do They Mean in a Video Game?" and "The Mathematical Concepts of Color Harmony." In the latter seminar, Wels showed *Graphical Harmony*, a film made for the Polaroid Corporation. The film argues that computer graphics are "a new medium in human culture" and programmers must understand how colors function in order to design sophisticated human-computer applications.[26] Wels recalled being intrigued by the psychology of color, to ensure "colors played nice with each other" when designing videogames.

In mid-1983, Daniel Bass and Karl Morris circulated a memorandum announcing that some of Intellivision's sixteen colors could play nice together when using a programming trick to combine them. "Are you tired of the same dingy colors out of your Intellivision?" read the memo, "Well, have no fear! A whole new world of color awaits those who shuffle bits at interrupt time. By alternating between two colors each sixtieth of a second, a total of 240 additional colors are possible."[27] Bass and Morris identified fifty-four of these 240 "bi-colors" as acceptable, without distracting flickering. Identifying acceptable bi-colors turned flicker—forbidden for multiplexed moving objects—into an acceptable trick to address inferiority in color. Bass and Morris developed a tool named "Rainbow" to access these fifty-four bi-colors, which "quadruples the current Intellivision palette."[28] Bass recalled experimenting with the technique when programming *Tower of Doom*, although it is unclear if bi-colors were used in other videogames.

Rainbow exemplifies how engineers knew that colors could bleed and interact in unique ways on CRT screens. Programmers exploited these color effects—effects that stemmed not from Intellivision's chipset but from affordances of the television. In *Masters of The Universe: The Power of He-Man*, Goldman's eerie backgrounds (like the ice-covered mountains or the multilayered forest of pine trees behind Castle Grayskull) produce detailed horizons of light and shadow, the colors bleeding together to create rich contrasts and

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depth. In *Vectron*, Goldman's shimmering graphics leverage color interaction on a television to compliment the videogame's themes. Players control a "V"-shaped gun composed of yellow diagonal lines separated by a dark green space. A yellow-green color moves down this "V" to create a sense of blurry, shimmering energy, an artifact produced when yellow-green moves against dark green. This effect is not part of the code, but it is part of the design. Emulating *Vectron* using a computer monitor removes these flourishes. Goldman extended this technique to layering moving objects, which manipulated their colors. The programmer Mark Kennedy emphasized that Goldman "discovered something in the hardware, that if you had two objects drawn on top of each other and there was motion, that you would get this weird kind of shimmering effect." The technique was used to create complex, colorful objects like the knight and dragon in *Thunder Castle*.

Time as Affordance

Not all affordance zones were computational. Time-to-market pressures constrained chip design—like the color processor—but also impacted game design and production. For example, Intellivision development pivoted around the Consumer Electronics Show (CES). During the late 1970s and early 1980s, CES took place twice a year—"Winter CES" held in January in Las Vegas, and "Summer CES" held in June in Chicago. With regard to videogames, Winter CES was a crucial event where "most of the press learned and told people the first hint of what would be under their Christmas trees later that year."[29] This was analogous to Toy Fair, the massive February event where Mattel traditionally presented its toy line for the year. By 1983, Winter CES was the largest of the approximately ten thousand annual trade shows held in the United States.[30] If the STIC provided the technical metronome and heartbeat of Intellivision games, updating the screen sixty times a second, Winter and Summer CES were the social heartbeats of videogame development, with the former orienting work toward the next holiday season.

Since Intellivision was sold to retailers and distributors, CES shows (particularly Winter) were where they learned about new products and made purchasing decisions. CES was a massive undertaking for Mattel Electronics, involving timing and coordination between engineers, programmers, sales, marketing, and management. APh personnel would be involved as well. As Manager of Retail Development for most of this period, Sharon Verduzco said, "I did everything that was outside of direct sales," from booking hotel rooms to arriving days early to set up the booth area. There were usually two days of pre-convention regional and national meetings where, as Senior Vice President of Marketing Frank O'Connell noted, executives "covered the product

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line and promotional offerings" for sales representatives.[31] During the main event, retailers and distributors could walk through the Mattel Electronics displays, talk to marketing and sales staff, and play videogames.

To have products ready for sale well before the next Christmas season, Intellivision development pivoted around the Winter CES. A game slated for a December release often required a convincing demo at the CES the previous January, eleven months earlier. Concerns that a game would not be ready for CES were a constant theme in interactions between programmers, managers, and executives.[32] Project timelines stated cartridges needed to be "available for CES" rather than Christmas.[33] In one humorous short film made by Applications Software programmers, the Quality Assurance (QA) staff member Dale Lynn answers the phone: "I know it's Christmas Eve but there's nothing I can do, dear. I'm right in the middle of burning 'Number Jumble.' I have to have it ready by CES."

Time thus formed an overarching affordance that trickled down to the daily work of videogame design. Developing and testing game code could be a slow and tedious process, and schedules were tight. The programmer Mark Urbaniec emphasized that deadlines were constantly in mind. "You're assigned a game. You have this small amount of time to get started before someone looks at you and says, 'We need to put this onto the schedule. When will the game be finished?'" Goldman recalled many occasions where "I had to get this out of the door by the next day and I would work till midnight trying to get this thing finished." These temporal affordances intersected with domestic life in ways shaped by gender and class. Goldman explained that "I was always worried, I have to get home on time to pick up my child from daycare. But I would get all that arranged." Such pressures led to trade-offs that impacted videogames. Fisher recalled proposing that *Space Hawk* include sliders allowing players to adjust different abilities like speed and firing rate, but Baum replied, "We don't have time. You need to move on to *Space Spartans*."

Time pressure could also shape success. Daglow presented an award to Kaestner that included extensive praise for his work on *BurgerTime*. Daglow explained that the original *BurgerTime* arcade game "uses as many as fourteen moving objects at once when Intellivision handles only eight," and Kaestner had to "solve this problem" while completing *BurgerTime* "faster than any other cartridge has ever been programmed if Marketing were to meet their target date. Three months later *BurgerTime* was done, an apparently impossible deadline was met."[34] The award recognized Kaestner's use of programming tricks to surmount limitations, indicating that "graphic sleights-of-hand" (like the disappearing yolk) were crucial to getting the job done on time.[35] In other words, computational and temporal constraints intersected. Responses to

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computational constraints did not only have creative consequences for code and game aesthetics. They could also have temporal consequences, speeding development. Moreover, Kaestner recalled that the rapidity with which *Burger-Time* was coded meant there was a month for testing and tuning the gameplay, "something that rarely happens in this business."

Time loomed large for QA, the last step before manufacturing. Baum emphasized that in the early years, "the games were always late. So we'd use the QA time to go on developing the game." When representing APh at planning meetings, Heather Edison (later Brendel), APh's Chief Executive Officer, recalled Mattel Electronics staff asking, "'Why is this bug taking so long to fix? Can't we release it anyway?' They were willing to release things with what APh thought were fatal bugs. I replied, 'You don't want to do that. They'll never buy a game from you again. We need some time to fix this.'" However, sometimes deadlines were solid. Daglow once informed QA about the urgency of confirming four games for the January 1983 CES, adding that "I've already informed my staff that any 'fixes' cannot . . . cause schedule slips."[36]

A remarkable example of intersecting temporal and computational constraint appeared when Fisher and Stephen Roney were helping complete *B-17 Bomber* because the voice extension Intellivoice was hitting the market in September 1982 (chapter 9). For this reason, by a certain Friday in July, ROM master images had to be flown to an Arizona factory for production. Because *B-17 Bomber* was an Intellivoice game, its cartridge was 12 KD—three times the standard cartridge, but around 5KD was taken up by voice audio files. Game code consumed all but one of the approximately seven thousand remaining decles. That Friday morning, the programmers discovered a significant bug involving a math operation going out of range. Fisher recalled that "it took three decles to fix. And there was only one decle left. We had to find two decles somewhere that would not destroy the game, with no time to spare. I had exactly four hours to find the bug, fix the bug, burn the ROM." The end of *B-17 Bomber* used a J $-3 ("jump") instruction, and Fisher noted that the command took three decles and "just goes back to the same spot again and again. We literally went into an infinite loop at the end."[37] Removing the J $-3 command would free up enough space to fix the bug, but there would have to be another way to end the game.

Fisher remembered that the CP1610's orthogonality meant that programmers could apply most CPU operations to any of its eight general-use registers (chapter 5). This included the increment and decrement operations, which add or subtract 1 from their operand. Fisher emphasized that register 7 (R7) holds and increments the program counter: "R7 is always pointing to where you are, right now. And every time you execute an instruction it increments a couple decles and goes to the next instruction." In theory, Fisher wondered,

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decrementing the program counter (DEC R7) would cause R7 to execute, then "immediately step it back to where you just were. So, it's going to add one, subtract one, add one, subtract one, add one, subtract one, which is going to net result you're in the same spot." Like J $-3, DEC R7 could halt the videogame, but Fisher emphasized that unlike J $-3, "decrement is a one-decle instruction. Tried it. It worked. I fixed the bug, tested the bug, handed it to another guy who spent half an hour playing the game and verifying that it worked, burned the ROMs, put them on an airplane, and made the deadline."

Licensing as Affordance

The Marketing Analyst Jim Goldberger noted that "Mattel was always very licensing driven. And that's because of shorter product life cycles. If you can get a license right off the bat, that was always a key to success." Mattel Electronics' emphasis on videogame licensing was shaped by its growing use in toys and hobby products. US sales of licensed goods reached $8.1 billion in 1979 and expanded an additional 33 percent by 1980, with toys alone accounting for 30 percent of these sales.[38] Moreover, as marketing researcher Cory Schwartz noted, videogames sold because their concept was appealing not just because they were fun, so "the implication of that was to get licensed titles."

This affordance zone took three forms: professional licenses, arcade/videogame licenses, and film/television licenses. Across these forms game designers used licenses as inspiration for graphics and gameplay, ruminating about whether certain licensed properties could be converted into videogames. Crucially, licenses were imposed on game designers by managers and marketers. Thus, they were experienced as constraints. For example, Kennedy found out that his videogame "Three Blonde Mice" would need to change to feature the character Top Cat, acquired from a Hanna-Barbera license. Kennedy felt "this is horrible. It makes no sense. And I was so upset that I was approaching the point where I was going to delete the source code." Kennedy agreed when another Hanna-Barbera character, Scooby Doo, was suggested instead. Indeed, licenses could be reframed as conduits for new possibilities. Daglow noted in a memorandum to Intellivision programmers that "licenses or premises were given to us by Marketing, but individual creativity made the cartridges successful" and required "a great deal of subtle game design."[39]

Most of Intellivision's first licensed titles were professionally licensed sports videogames, including *Major League Baseball*, *NBA Basketball*, and *NASL Soccer*. Mattel had a history of licensed sports toys—for example, the "Instant Replay" record player from 1971, which used small plastic disks to

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play back audio of famous sports events. Intellivision sports licenses were not proprietary—other companies could, for instance, still make baseball videogames. Instead, the licenses confirmed authenticity and thus realism. For the teenagers who were Intellivision's core market, these licenses were aspirational, bringing players closer to the professionals.

At the time, professional organizations expressed little interest in their videogames. The programmer Bob Del Principe recalled that "the NFL was like, 'I don't care.'" This disinterest was reflected in the minor fees involved (advances ranged from $2,500 to $10,000; the guaranteed minimum ranged from $10,000 to $150,000).[40] Crucially, the impact of sports licenses did not involve license owners demanding changes to videogames. Instead, the added authenticity of the sports licenses meant that programmers strove toward realism, shaping their decisions of how to represent the game.

Arcade/game licenses followed soon after the sports licenses and were substantially more expensive. Advances ranged from $25,000 to $250,000. The guaranteed minimum to be paid was as high as $3,000,000, to TSR for *Advanced Dungeons & Dragons.*[41] This license was so high because Mattel's electronic board game *Dungeons & Dragons Computer Labyrinth Game* had been a top-selling game in 1980. To secure a license, the Product Manager Kathy Austin Lockton, who conceived of the idea for the original electronic board game, traveled to Wisconsin to meet TSR cofounder Gary Gygax. *Computer Labyrinth*'s success paved the way for the Intellivision *Dungeons & Dragons* licenses, but also for their high price.

Lockton said that Gygax was involved in the design of *Computer Labyrinth*. However, TSR provided little input for the *Advanced Dungeons & Dragons* Intellivision games. Gygax and others presumably approved the cartridge before release but never requested communication with Loughry as work progressed. Like sports licenses, the impact of the *Dungeons & Dragons* licenses was aspirational: the videogames were to invoke the experience of the role-playing game. In *Advanced Dungeons & Dragons*, this included battling beasts in dungeons, gaining items like a boat to cross rivers or an ax to cross forests. In *Advanced Dungeons & Dragons: Treasures of Tarmin*, this included gaining power through finding upgraded weapons. Loughry recalled that when designing the games, "the whole point of any of these kinds of games is character development. You want to boost character skills in one thing or another." The license acted as an affordance zone, shaping a thematic authenticity that referenced fantasy role-playing games instead of reality as such.

Early on, Mattel Electronics was lax with regard to arcade licenses. Why bother? The arcade industry going back to *Pong* in the mid-1970s was rife with copycats. Intellivision titles like *Space Armada,* a partial clone of *Space Invaders*, skirted copyright infringement with no apparent consequences. Mattel

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Electronics attempted to repeat this pattern in late 1980 when Sohl was asked to prototype an *Asteroids*-like videogame for the June 1981 CES. Sohl flew to Chicago to see it demonstrated, recalling that "the people from Atari came by within an hour and said, 'If that's on that screen for another hour, we'll be in court.' The intellectual property laws had changed." Baum passed the code to Fisher, who recalled Baum's directive to "make a game that's like *Asteroids* that's not *Asteroids*. And that was what became *Space Hawk*."

Because Atari and Coleco moved more swiftly with arcade licensing, Mattel Electronics was forced to secure agreements with relatively minor companies: Konami (*Loco-Motion*) and Data East (*Bump 'N' Jump*, *Burger Time*, *Lock 'n' Chase*, *Mission X*). Although fidelity to the original was pivotal to these licenses, occasionally the original gameplay was modified. One Data East title was *Disco No. 1*, where a man danced around women to trap them (chapter 4). The programmer Keith Robinson proposed reframing the gameplay as a penguin, Duncan, who would skate on a frozen lake and cut holes in the ice to dunk other penguins.[42] One month later, Baum forwarded the idea to Mattel's executive staff, noting it would convert *Disco No. 1* "into an almost identical game with different graphics that avoid both the sexist aspect and the disco themes" of the original.[43] Thus, *Disco No.* 1 became Intellivision's *Thin Ice*. While name recognition was an important aspect of most licenses, *Thin Ice* only retained the game mechanics. Crucially, Intellivision's background grid facilitated *Thin Ice's* development.[44] Duncan traverses the grid, and the holes are created by changing the color of enclosed background cards. Hoshizaki, *Thin Ice's* programmer, noted that "when I was drawing Duncan's path to the background, I had to do it in the squares in the background. I could have built a more smoothly drawn path, but I was really thinking about that [background] part." Choosing games to convert based on Intellivision's computational affordances was an important part of navigating licensed possibilities.

Film and television licenses began with *Word Fun* and *Math Fun*, programmed at APh under a license from the Children's Television Workshop's *The Electric Company*. As with arcades, taking ideas from movies and television shows was not seen as unequivocally illegal. APh's Glenn Hightower had an idea for a videogame based on the Death Star trench scene at the end of *Star Wars*. The idea was developed primarily by APh programmer Hal Finney, with design work by Loughry, whose initial description was "a fighter-pilot game set on the Death Star" involving X-Wing and TIE fighters.[45] The idea was "prepared and presented to George Lucas as 'Star Wars,'" but Loughry noted that an agreement was never reached: "Initially we were wanting Mattel to get the license. So in the first draft of the design document I didn't hide that it was a rip off. But they couldn't get the license, so we had to switch some things around."[46] The game eventually appeared as *Star Strike*, with the player's

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ship now flying in the trench of "an enormous, threatening space cruiser."[47] A failed license still acted as an affordance.[48] While no longer referencing *Star Wars*, gameplay involved flying a spaceship through a trench to destroy a giant enemy ship before it obliterated a planet in the distance.

Eventually Mattel Electronics acquired licenses to a staggering 125 cartoon characters from Hanna-Barbera and other companies—from *The Jetsons* to *The Addams Family* and *The Yogi Bear Show*.[49] Licensing characters intersected with computational affordances, since they had to be drawn within the constraints of Intellivision graphics. Baum wrote to Pete Pirner, Senior Vice President of Marketing, expressing concern that many Hanna-Barbera characters would be "non-implementable" due to graphics limitations.[50] Pirner's handwritten reply confirmed that "our final choice of characters will of course depend on what's doable, what's popular."[51]

Promotion as Affordance

Promotional campaigns (sometimes called "commercial tie-ins") were created for several videogames, extending beyond the typical licensing arrangement. The campaign for *BurgerTime*, for example, included a major promotion with Wendy's and a sweepstakes with McDonald's and Eastern Airlines.[52] Mattel Electronics also created videogames to promote Disney's movie *Tron* (1982)—Intellivision's "first major scoop," Del Principe emphasized, because Atari had been seeking the license. Since *Tron* pioneered computer-generated graphics, videogame tie-ins made sense. Del Principe recalled that programmers had access to the film before it was released to aid their designs, and a group of programmers even visited Disney to view "rushes" (unedited footage).[53] Eventually, Mattel Electronics released three *Tron* videogames, including *Deadly Discs* and *Maze-A-Tron*, shortly after the film's release.

Another example of promotion as affordance involved "Kool-Aid Man," an animated character advertising the flavored drink by General Foods. By the late 1970s Kool-Aid Man had become one of the most successful icons in American advertising. Kool-Aid Man had 96 percent recognition among children and was better liked than any other advertising character, including Ronald McDonald.[54] In 1982, General Foods hired Mattel Electronics to produce a promotional videogame based on Kool-Aid Man within six months, and "a two-week contest to come up with the best game concept was announced."[55] Programmer Russ Haft circulated a memo informing the programmers that "several Kool-Aid commercials will be shown. This should be very helpful in familiarizing everyone with all of the players in the

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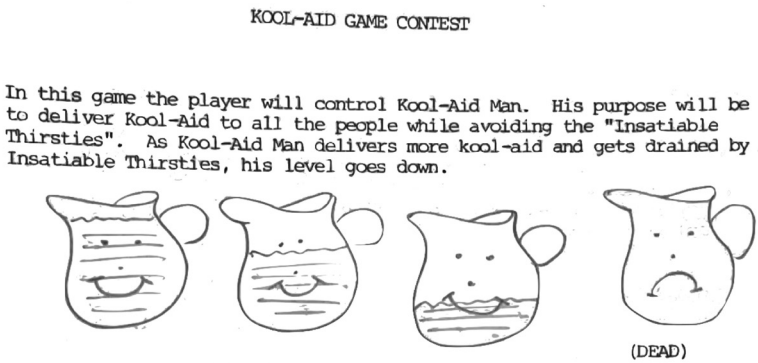

7.1 Contest entry depicting dying Kool-Aid Man ("Kool-Aid Man Game Proposals," National Videogame Museum archive).

Kool-Aid scenario"—Kool-Aid Man, one or more children, and the enemy "Thirsties."[56] The winning entry, by Vladimir Hrycenko, featured children chased by Thirsties in what "looks like the 'cut-away' of a multistory house."[57] As a reward for agreeing to use Scooby Doo in his game, Kennedy was offered the opportunity to develop Hrycenko's proposal.

The promotion imposed very specific affordances on the game design. General Foods insisted that Kool-Aid Man "is always full, he never sloshes or spills," that the character "can never harm anyone, he is a happy soul," and that "the children in the game can come to no harm."[58] Their concern was justified: in one programmer's contest entry, Kool-Aid Man could die (figure 7.1). The final version of *Kool-Aid Man* addressed General Foods's stipulations and featured a giant Kool-Aid Man bursting through a wall—an innovative use of Intellivision's eight moving objects to animate a large figure. The animation replicated the imagery of the well-known Kool-Aid Man television commercials and represents one of the first cutscenes in home videogame history. In the final release—which consumers could acquire by sending in proof-of-purchases from Kool-Aid products—the children never died but "froze" when touched by a Thirstie, uttering a scream. Since this sound potentially broke the marketing restrictions, the General Foods staff found the scream disturbing. However, given time constraints and the fact that Kennedy had left Mattel Electronics one day earlier, the scream remained.[59]

Reflecting internal conflict, there were almost no promotions between Mattel Toys and Mattel Electronics—for example, creating a Barbie videogame (see chapter 4). Gary Schwandner, Senior Vice President for Manufacturing at Mattel Toys, emphasized that "it shows you some of the limited

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thinking that was going on, and some of the competition between the electronics division and the toy company." Tom Kalinske, at the time Senior Vice President of Marketing, noted that "I was very, very protective of Barbie. If Barbie is portrayed by an actress who ends up doing something they shouldn't have done, it could ruin the Barbie brand. Or if they did a movie and it failed, what impact would that have?" Mattel's Legal division shared these concerns. Mike Weinstock, Vice President of the division, emphasized that "everyone in the world wanted to license Barbie for one thing or another, but Mattel felt the brand was just too valuable a franchise to squander."

More perplexing is that Mattel Electronics never developed a Hot Wheels videogame. Hot Wheels were seen as boy's toys, and one of the earliest Intellivision titles, *Auto Race*, could have been promoted as a Hot Wheels videogame. Executives like Josh Denham and Stav Prodromou recalled Hot Wheels titles being considered. One brainstorming session included a car videogame "possibly with Hot Wheel [sic] license."[60] The idea was dropped despite the fact that, as marketing researcher Marty Miller noted, "in retrospect obviously it made a lot of sense." When suggesting the idea during an interview, Denham exclaimed, "If you'd been there to suggest it we probably would have done it and given you a promotion!" One key factor likely hindering the development of Barbie and Hot Wheels videogames was that these were toys for younger children. Intellivision initially was marketed to an older audience of teenage boys and even adults. Thus, beyond brand protection, and even intercompany competition between Mattel Electronics and Mattel Toys, Intellivision's perceived sophistication could sever potential connections to toys.

In one case, however, the generational distinction between toys and Intellivision did not prevent a promotional arrangement between Mattel Toys and Mattel Electronics. This involved Masters of the Universe, which was developed after Mattel Toys President Ray Wagner passed on producing *Star Wars* action figures.[61] Revolving around the hero He-Man and the villain Skeletor, the Masters of the Universe toy line was released in 1982 and sold over five million figures in its first year.[62] One reason for this success was that the toy figures were paired with comic books and an animated television series. He-Man's transmedia promotions and appeal to boys may explain why Mattel Toys allowed Mattel Electronics to move forward with a videogame. The primary programmers, Kaestner and Rick Koenig, watched the television show every day from their Applications Software offices. Kaestner recalled, "They had to string up a special antenna to get television reception in the steel building. My goal was to use some of the cartoon show ideas as part of the game," adding that "the main instruction I had was that no one in the game could die."[63] Working within that constraint, Kaestner and Koenig designed a narrative where He-Man and Skeletor have a swordfight with no fatalities.[64]

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Mattel Electronics sent graphic designer Goldman to a convention in New York to study the He-Man universe. Along with Koenig and Kaestner developing computational techniques for accelerated action, smoother gameplay, and the illusion of having many moving objects onscreen simultaneously, Goldman's stunning innovations—like the eerie layered graphics behind Castle Grayskull mentioned earlier—were coined "SuperGraphics" by Mattel's marketers. The phrase eventually extended to any title with well-done graphics.[65] By the June 1983 CES, "nearly every Intellivision game on display . . . carried the SuperGraphics logo," but only *Masters of the Universe* was released with "SuperGraphics" on its box.[66] The term implies new hardware, and in a press release Pirner was quoted as stating that "SuperGraphics is made possible by the new and exclusive Mattel Electronics Graphics Development System, the GDS-7809."[67] As Warhol noted, in reality no such system existed: "What it really meant was that they put an extra 4K of graphics on there and that Connie Goldman worked on the project." When presenting Goldman with an award, Daglow exclaimed she had "changed our programmer's—and soon, the consumer's—vision of the Intellivision," with graphics "so materially superior to those of our competitors—despite their more powerful hardware—that they change the graphics 'balance of power' back towards our direction."[68] Without a next-generation system on the market in 1983, Mattel Electronics struggled to stay relevant, and "SuperGraphics" became a way to market technological innovation that seemed to push beyond the constraints of Intellivision's platform.

Bugs into Features

Affordance zones often intersected, merging social and technological considerations to create historically specific practices. For example, occasionally an unexpected aspect of design—originating in error or computational compromise—would be transformed into a quasi-intentional aspect of gameplay. A common phrase for this process of re-narration is "turning a bug into a feature," a creative transformation of constraint.

"Bugs" might imply things easily squashed, but they presented a particular challenge for videogame designers of the second generation. Indeed, Warhol recalled the sense that "50% of the time I'm a programmer and the other 50% of the time I'm a debugger." Each new cartridge could contain bugs, and no internet existed for patches or updates. As programmer Bob Newstadt emphasized, "It was final and you made thousands of copies of it and you couldn't get it back." The *B-17 Bomber* example previously discussed illustrates the preferred procedure of debugging before release. Another possibility was to leave a bug in the code. Consumers might discover it, but

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customer support could claim the bug occurs "occasionally in certain circumstances" while offering a replacement cartridge containing the same code.[69] Yet complaints were not inevitable. Bugs could be a source of amusement or act as "cheats" allowing players to succeed.[70] Ultimately, fixing a bug required thinking in terms of trade-offs: would fixing it take too long or require cutting features to make space in an already-packed cartridge?

The phrase "running change" or "programming change" referred to an updated cartridge that eliminated a bug. Daglow noted that this was a major undertaking and carried risks, including the cost of testing and manufacturing the new cartridge, the possibility that retailers might demand the old cartridge be returned, and the chance of introducing new bugs.[71] Running changes were the only option in cases where bugs significantly degraded gameplay. For example, 11.1 percent of *Star Strike* cartridges were defective.[72] One distributor reported that multiple customers "complained that when they used the left hand controller the user fighter would frequently freeze on the screen. I was able to consistently reproduce this bug."[73] Five months later a decision was made to "initiate a programming change . . . to eliminate the left-vs.-right-hand controller problem."[74]

Intellivision bugs were often redefined when discovered, and the fact that videogames came with manuals was crucial to this narration. Mattel Electronics' QA process included detailed "Test Reports." These were important occasions to document bugs and decide if they could be turned into features. For example, the final Test Report for *Maze-A-Tron* identified six bugs. These included background maze graphics that could trap players, the ability for an enemy just offscreen to kill players due to scrolling effects, and a sound lasting too long and misleading players into thinking their shields were active.[75] Hugh Barnes, Senior Vice President for Operations, forwarded the Test Report to Daglow, with a post-it-note asking if "these problems fall into the 'fixable' category or 'can't fix it—feature it' category."[76] Daglow replied that the problems were "all 'fixable' through instructions. I see no reason to hold the ROMs."[77] Here, temporal and promotional affordances intersect because *Tron* was already in theaters, leading to the emergence of quick fixes using the manual.

Turning bugs into features could thus take computational or narrative form. When replying to Barnes regarding the three *Maze-A-Tron* bugs mentioned, Daglow suggested that the background graphics bug could be "explained in instructions—not worth the 200 decles to fix, since it's rare and avoidable."[78] The revised manual warned, "It is possible to get stuck in [the graphics] if you go into them too far. The result is that you will be moved off the screen." In other cases a bug could be featured in the game narrative.

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For example, with regard to the second *Maze-A-Tron* bug involving scrolling, Daglow asserted that this "is a game feature—players shouldn't hug the 'leading edge.'"[79] The revised manual followed Daglow's suggestion, warning players to stay away "from the sides of the screen" because an enemy "may be waiting just off-screen." A particularly clear example of featuring a bug in the game narrative involves *Space Hawk*, where pressing 9 on the keypad teleports the player to a new place. During gameplay, this "hyperspace" feature sometimes triggers on its own. On the final page of the code, Fisher commented that "a reasonable fix must be found for the hyperspace bug."[80] None was found, and the manual simply asserted that "every once in a while, your space hunter will move near a 'black hole,' and the computer will automatically put him into hyperspace."

Another instance of featuring a bug involved *Utopia*, a videogame with two islands around which players can move boats. Daglow, who programmed *Utopia*, wrote an algorithm that prohibited sailing directly toward land when in close proximity. Boats stop half a background card from the shore. Intellivision expert Joe Zbiciak explained that "the collision code looks one card ahead in the direction of travel, and stops you from going in that direction if there's an obstruction. The issue is that it doesn't take into account where you are within a card. Once you're halfway into a card, you're 'in the card' and that's all it looks at."[81] Since the code uses the center of the boat to find the background card beneath it, once a boat is halfway into a card that abuts a card with land, it can no longer move toward that land. The code is triggered and the boat is stopped, even though there still appears to be water between the boat and land. However, movement parallel to the land is unaffected because Daglow's code looks in the direction of movement one card ahead of the boat; if traveling parallel to the land with open water ahead, the code does not stop the boat. Strangely, this means that a boat might be stopped about 4 pixels away from land if headed straight into it, but if moving parallel to the land, the boat can freely travel up against the shore!

The test report for *Utopia* identified these as bugs, noting "there are 'sand bars' which prevent ships from approaching certain areas of the shore from some directions but do not inhibit motion away from the shore."[82] However, the report also noted that "Marketing does not consider them to be a defect."[83] As a result, the decision was made to turn this bug into a feature. The phrase "sand bar," originating in a QA test report, was incorporated into the manual: "Watch out for invisible sand bars near the shore lines. They can slow you down when you are trying to move quickly. Avoid sand bars by moving parallel to shore whenever possible."[84] This was an elegant narrative solution. The manual not only explained away the bug but told players how to

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circumnavigate it. The bug even became a feature of gameplay. Players have "PT boats" they can use to sink opponent fishing boats, and one way to do this is by trapping a fishing boat against a sandbar.

Ghosts in the Game Machine

Intellivision programmers played in affordance zones as they designed videogames. They turned deadlines, limited colors, or a *Major League Baseball* license into code. These affordance zones often had consequences for gameplay, like *Utopia*'s sandbars. But this was not always the case. Fisher's solution to fixing the *B-17 Bomber* bug is not apparent to players: "Game over" happens one way or another. This is one dimension of what, in the Introduction, we term a "platform archaeology" approach. Layers of history are not always visible: the remains of villages might appear as flat earth to the naked eye. But we can unearth how constraints and affordances influenced game development.

Precisely because they do not manifest explicitly in gameplay, these ghosts in the game machine remain unknown unless somehow recorded for posterity. One such "ghost" involved the platform itself. Intellivision's programming manual, "Your Friend, The EXEC," contains a chapter "System Bugs." This "chapter" is but one blank page with the haunting sentence "Moving object #1 does not interact with the right border" (figure 7.2). Compounding the mystery is that this singular system bug does not exist: all eight moving objects interact with the playfield's right border in Intellivision games.

The sentence might relate to another absence: Intellivision's playfield is 159 pixels wide, not 160—the expected width of a display made from twenty background cards, each 8 pixels wide. Paired with this unusual width, the ghostly sentence has fed speculation that a right-border bug involving moving object #1 existed in an earlier hardware configuration and that the playfield was reduced by one pixel on the right to eliminate it. To produce moving object interactions with the borders, there is a pixel-wide frame around the active playfield to trigger interactions with moving objects that the STIC records. Had the playfield originally been 160 pixels wide, this border would have been placed at the 161st pixel. Yet, as Zbiciak noted, "It's entirely possible the bug was due to an interaction between the first object picture fetch and delaying the right border collision to column 161."[85] The STIC has a miniscule amount of time to compute border collisions before it needs to fetch new moving object data for the next scanline. Zbiciak added that there "may not have been enough time to hold the current object bitmaps in their respective shift registers and compute the collision with the right border."[86] Hence, the STIC needed a bit more time. Maine did not recall the precise problem, but he emphasized that "at some point in time

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CHAPTER 6

SYSTEM BUGS

6.1 HARDWARE

Moving object #1 does not interact with the right border.

7.2 Page from the Intellivision programming manual "Your Friend, The EXEC," "System Bugs" (David Rolfe, "Your Friend, The EXEC," June 22, 1981, Blue Sky Rangers archive, page 6-1).

we discovered that under certain operating conditions we were a cycle short and we did not want a vertical black bar through a lack of video."[87] To make room for that cycle, and perhaps to allow moving object #1 time to interact with the right border, the playfield's displayed width was reduced to 159.

This 159-pixel width is a limitation without affordance, a constraint without creativity, an unproductive detail. Few programmers we interviewed mentioned its existence. STIC documentation lists it as a technical fact, simply stating that the twentieth card in all background rows is 7×8 pixels.[88] In comments on Intellivision hardware written in 1980, Sohl deemed the 159-pixel width an "obscure note."[89] Indeed, it is a detail obscured by history, failed recollection, and holes in the archive like the absence of a STIC circuit schematic. Perhaps its true cause will be discovered, perhaps not.

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Sigmund Freud noted that there is "often a passage in even the most thoroughly interpreted dream which has to be left obscure . . . This is the dream's navel, the spot where it reaches down into the unknown."[90] Perhaps Intellivision's missing column of pixels is its dream navel. What do we gain by knowing its true meaning? Why would we want to discover it? Such questions linger at the methodological heart of platform studies, which often employs technical description. Details like the 159-pixel width entangle technological, economic, and social realities, providing windows into human culture, history, and society. The missing column means different things to different people: a pesky production bug for engineers; a tiny annoyance to graphic designers; a technical enigma for hobbyists and experts; a passing mention for Wikipedia authors and gamer enthusiasts; an esoteric quirk or beauty mark that becomes endearing to an Intellivision fan; and an important detail for programmers building Intellivision emulators.

But what does it mean for authors writing a book about Intellivision? It testifies to the STIC's state-of-the-art technology: engineers packed so many features into the chip's design that one seam simply burst. It reveals the pressures, timelines, trade-offs, and costs of commodity production, since fixing the issue with an awkward playfield of 159 columns was less important than product delivery. It testifies to technological contingency. It is a mystery to engage our desire to know the unknown. It is a constraint that is unproductive, that does not produce haikus, but is nonetheless poetic. These ghosts in the machine show how affordance zones permeate beyond the visible, revealing platforms less as stable foundations and more as contingent formations of technology and culture.

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Boom

8

For a brief moment Intellivision was bigger than Barbie and Hot Wheels combined. From the 1980 to 1982 Christmas seasons, Intellivision experienced an unprecedented boom. The rapid growth crowned Mattel Electronics as Mattel's most lucrative division. This led to an identity crisis. Was Mattel a toy company? Josh Denham, by this time President of Mattel Electronics, emphasized that "the board really was thinking that the electronics business was going to be Mattel in the future. And they thought that the toy business had plateaued. A total mistake on their part." It was a mistake because the entire US videogame industry would crash a few years later.

A "boom" implies sudden growth but also a lack of control and potential for explosive damage. The metaphor is apt. This was an exciting time of expansion, but also a chaotic time of unsustainable assumptions about the videogame market. In June 1982 one key trade magazine claimed it was "high noon for games," noting that despite "booming demand"—and industry leaders predicting "Mattel will ship some twelve million cartridges this year"—it "seems obvious" that some videogame companies "won't be around at this time next year."[1] Disregarding warnings that videogames were at their zenith, executives concluded the sun would never set. "I should have gone with my instincts that this is not going to do what everybody thinks it's going to do," Denham reflected years later, but at the time Denham decided to "just go with the flow and invest and try to expand as fast as we can."

During the boom, Mattel Electronics both innovated and iterated. The division entered a period of significant expansion, what we term "hyperextension"—for example, creating their own programming group,

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developing hardware extensions and next-generation systems, converting Intellivision titles to Atari, and expanding space and arcade offerings. Much of this hyperextension involved innovating new organizational structures and even forms of game design. However, Mattel Electronics also repeated and varied past successes, reacting to industry developments instead of disrupting them. Iteration had been central to Mattel's philosophy since the earliest days of Ruth and Elliot Handler, from Chatty Cathy to Barbie and Hot Wheels, with their line extensions and never-ending accessories. At Mattel Electronics, iteration would lead to a redesigned Master Component that literally cut corners to reduce cost, as well as sticking with an aging advertising campaign. Ironically, it also led to a turn away from Intellivsion's innovative sports videogames—and even sophisticated strategy—in favor of copying the industry trend toward action, arcade, and space titles. Thus, hyperextension produced a tension between differentiating the console and co-opting features of competitor consoles—even if this blurred the distinctiveness of Intellivision itself.

Mattel Electronics Unbound

During the boom, Mattel Electronics expanded further from Mattel Toys. By early 1981, dizzying growth was providing new momentum for Mattel Electronics becoming completely independent. Paul Rioux, Senior Vice President for Finance and Planning, noted that after the January 1981 Consumer Electronics Show (CES), Mattel Electronics "began hiring more people from outside the Toy division, increased our 1981 forecast on unit volumes and dollars, and began planning for a move to a separate facility."[2] Coverage from the June 1981 CES concluded that consoles "wore new mantle of respectability stemming from awareness of massive profits starting to be made from cartridge sales," mentioning Intellivision had sold 200,000 consoles.[3] Amidst this growth, in July 1981 Mattel announced "plans for immediate separation of Mattel Electronics from Mattel Toys to form a new stand-alone division."[4] While this reorganization occurred, about 4.5 million consoles sold in 1981, and one million were Intellivisions.[5]

The remarkable growth continued through 1982, with one report estimating that between January and December, the percentage of US homes with televisions that also had a console rose from 8.5 percent to 17 percent.[6] By the end of 1982, over two million Intellivisions had sold.[7] Mattel Electronics had 1982 profits of over $100 million based on revenues of $556 million, exceeding Mattel Toys' revenue of $528 million.[8] To many, videogames appeared to be Mattel's future. In June 1982, Mattel's Chairman, Art Spear, expected "'no erosion of market share' in home videogames."[9]

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By this point Spear was the tenth-highest-paid executive in the electronics industry, indicating how Mattel Electronics was driving Mattel's overall profitability.[10]

As Mattel Electronics became independent and grew, Applications Software—which housed Intellivision programmers—followed suit. Early in 1982 the group left the main Mattel building, moving into a warehouse down the block.[11] From mid-1981 to mid-1982, Applications Software boomed from twelve to forty-eight employees.[12] Mark Urbaniec, programmer and Group Leader, once interviewed eight potential new hires in one day. This fourfold growth accelerated over the next six months and was not limited to Applications Software. Dennis Marchand, Director of Recruiting, posted job ads throughout Southern California and even ran a career day at Mattel. At its peak, Mattel Electronics had about 1,800 employees.[13]

The explosive growth led to shortages of space and equipment. Programmer David Stifel recalled that Mattel Electronics didn't even have a desk for him on his first day. "They were completely unprepared for what they were doing," Stifel recalled. "They were just hiring left and right before they had facilities to support them. I think it was about three weeks before they finally found me a cube and workstation." In July 1982, the programmers and managers Don Daglow and Mike Minkoff warned that new hires were having to share equipment and even offices "since the ranks of the programmers have swelled faster than the rate at which equipment can be installed."[14] By September additional cubicles were being set up, but the following month nineteen programmers still lacked computers, seven of them for four months or longer.[15] Mattel Electronics was hyperextending, booming without a clear vision or organizational framework to channel the growth.

The sense of booming chaos was not limited to game development. Mike Weinstock, Vice President of Mattel's legal division, noted how during this time "Intellivision was an absolute legal disaster. They were moving so fast. They're making money hand over fist, and operationally a complete mess. They didn't get purchase orders. They didn't follow protocol models." Manufacturing deadlines could also be chaotic. Roger Rambeau, Vice-President and Managing Director for Manufacturing, noted that "if you don't get it on a ship by October, November, it doesn't make the shelf for Christmas." Rambeau recalled authorizing the rental of Boeing 747 jumbo jets to fly delayed cartridges manufactured in Hong Kong across the Pacific. The higher cost of last-minute air shipping was less damaging than missing an entire Christmas season.

The boom also led Mattel Electronics leadership to hire managers from the electronics and computer industry. Denham's hiring of Stav Prodromou

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from Texas Instruments (TI) as Senior Vice President of Operations was a watershed event, seen as an indication of Mattel's serious pivot into electronics. Prodromou brought in two former TI colleagues, Hugh Barnes and John Fairbanks, and the three executives were dubbed "the TI group."[16] David Chandler and Richard Chang, who as noted in earlier chapters were key engineers and managers behind Intellivision, now reported to Prodromou—a technology executive with no background in toys. This marked a decisive break from Mattel's expertise, orienting Mattel Electronics toward a world of technology whose profitability had not yet withstood the test of time.

Tom Kalinske, then Senior Vice President of Marketing for Mattel Toys, said that when Mattel Electronics separated from toys it was irksome: "I felt like they were getting more of the company resources than we were getting in the Toy division, so I was frankly jealous." When the boom was about to turn into a crash, Kalinske began hearing from Intellivision retailers that there was "too much inventory, too much oversupply." Concerned, he warned Mattel's board of directors, but "they didn't listen to me because they were so in love with the whole idea of this very successful Mattel Electronics division that was worth hundreds of millions of dollars more than what the Toy division was worth at the time."

Hyperextension

From its inception, Mattel Electronics used an analogy with stereos, a well-known domestic technology at the time, to design and market Intellivision in terms of what we called "modular extensibility" in the Introduction. With their cartridge ports, second-generation consoles like Intellivision opened into the future and the promise of expansion. The boom period fueled what we call hyperextension, an intensification of the logic of extension. Coupled with the newness of videogame platforms, hyperextension embodies the seemingly limitless and unrestrained imagination of possibility and profit. This concept is intended to capture not only the technical extension of Intellivision—hardware and software development—but also the rapid social, cultural, and organizational expansion of Mattel Electronics.

For example, during the boom Mattel Electronics expanded overseas, creating Mattel Electronics France in Sophia Antipolis (a technology park founded in 1969 outside Nice, France). Headed by Tim Scanlan, beginning in the fall of 1982 the programmers at Mattel Electronics France were developing games like "Hard Hat," a platform videogame somewhat like *Donkey Kong*, and "Illusions," featuring an Escher-like isometric point of view.[17] European-themed design appeared in titles like "ZZZZ! Starring Spina the

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Bee," based on the European cartoon character Maya the Bee, and "Super NASL Soccer." The latter was to use the Entertainment Computer System extension (chapter 10) to add two hand controllers for a four-player version of the popular European sport.[18] It was later released as the regular Intellivision game *World Cup Soccer*.

Technologically, Mattel Electronics pursued numerous products and ideas during the boom. While leadership continued to support the struggling Keyboard Component (eventually canceled near the end of the boom), several other extensions that we analyze in part III of this book were developed, including the Entertainment Computer System (ECS), Intellivoice, PlayCable, and the System Changer. Other ideas were pursued for teletext systems, home banking, 3D videogames, a collaboration with Sony to produce a portable videogame system, wireless controllers, and more. Chandler thought Mattel Electronics ought to "play a major role" in "home data communications," with Intellivision operating as a terminal in a home entertainment network.[19]

This hyperextension was fueled by unrestrained brainstorming. For example, in July 1981 managers held a "Blue Sky Session" event where employees were prodded for new ideas. Summarizing the discussion, the programmer John Sohl grouped the ideas in categories, beginning with suggestions for potential future extensions. In addition to less outlandish ideas like external RAM, these included extensions for weightlifting, monitoring brain waves, speech recognition, video discs, and laser guns. There were even suggestions for a mirror to project gameplay onto ceilings and a "Star Trek captains chair, with controllers on the arms."[20] Suggestions for "networking" included a telnet function that would make Intellivision "your window to the world" as well as a range of "remote 2 play[er] games"—for example, supporting online interaction like a treasure hunt game where only one player would get a clue. The brainstorming even included a "philosophy" category—general principles for Intellivision's future. One such suggestion read, "Every product in the future should be expandable."[21]

New videogames also were needed to counter Atari's massive library and their dominance in action, arcade, and space genres. Here too, employees were solicited, and hundreds of ideas emerged. Examples of never-developed games include "Fuzzball," where players prevent lint from forming a ball large enough to kill them, "Greenpeace," where "you're the crew of a small patrol boat out to save the whales," and "Fireflies and Moonbeams," where "fireflies fly through the night blinking on and off" and players "find and match fireflies among the moonbeams."[22]

For those within Mattel Electronics, hyperextension likely appeared as continuing the toy company's method of churning out ideas, refining

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them with input from marketing, and then manufacturing new products. Yet from perspectives outside the division, all was not swell at Mattel. Howard Polskin, the journalist who wrote the 1982 "Blue Sky Rangers" piece for *TV Guide*, had a unique perspective on this process. Attending a day-long brainstorming session at the time, Polskin wrote of ideas becoming "so strange I can't follow them," suggesting the programmers "have soared out of orbit."[23] Forty years later, Polskin remembered feeling "underwhelmed by what I saw," emphasizing that the sheer number of ideas "struck me as way overboard." To an outsider, the process appeared unwieldy and unproductive.

Mattel Toys was a creativity machine, with designers constantly hatching new ideas. However, central to its success were processes that channeled and evaluated this efflorescence of ideas, based on a longstanding knowledge of play value and children's play patterns. Mattel Electronics, as it expanded and separated from Mattel Toys, did not yet have such a robust, ingrained management workflow. Employees were generating ideas for an undefined, seemingly limitless product category, in an environment where evaluation structures were unclear. Indeed, hyperextension was in danger of becoming "overextension," an idea we explore in chapter 13 when discussing the crash of the US videogame industry.

From Sports to Space

Before the boom Mattel Electronics focused on sports videogames, a period Daglow dubbed "the Obvious Design of the Obvious Product."[24] However, shortly after Intellivision's national release in 1980, Sohl objected to the "emphasis on sports" and having "very few arcade-type games."[25] Sohl was not alone. Stellar sports cartridges earned Intellivision early brand awareness, but by 1981 marketing research recommended programmers "address Atari's major competitive strength, game variety" and expand Intellivision's catalog in the direction of space and arcade titles.[26] Vice President of Marketing Bill Gillis recalled that "consumers criticized Mattel for a lack of space games. We had to run flat out to come up with three or four space games."

The year 1981 saw the release of the space and arcade titles *Astrosmash, Snafu, Space Armada, Star Strike*, and *Triple Action*. *Astrosmash*'s success, competition from arcades, and Atari's dominance all led Mattel Electronics marketers and executives to demand Applications Software develop even more space and arcade games. By early 1982 market researchers ran focus groups "to determine the most appealing attributes of arcade games."[27] Later that year Craig Spitzer, Marketing Research Manager for Intellivision, acknowledged that sports titles "are also no longer the best sellers, as games

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BRAND IMAGE/POSITIONING

IN MID 1982, CONSUMERS HAD A CHOICE BETWEEN TWO DIFFERENTIATED BRANDS

CONSUMERS' CHOICE

ATARI	INTELLIVISION
LOW PRICED	HIGHER PRICED
POOR GRAPHICS	GOOD GRAPHICS
MORE GAMES	SPORTS GAMES
ARCADE GAMES	CHALLENGING
SPACE GAMES	
1 OR 2 PLAYER GAMES	
FUN FOR KIDS/TEENS	SOPHISTICATED FOR ADULTS

8.1 Internal marketing presentation slide showing rivalry during boom (Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, Cory Schwartz archive, 12).

based on arcade licenses and space dominate retail sales."[28] One fan magazine stressed that sports videogames were "one of the reasons why Mattel have [sic] sold less units than Atari. The former have been rather slow to come up with arcade titles which are far and away the most popular type of game."[29]

Pivoting from sports to space and arcade games was an innovation for Mattel Electronics, but given Atari's success, it was also an iteration. In Daglow's terms, it was obvious design of an obvious product. During the boom years, marketing researchers investigated the effects of Mattel Electronics' effort to differentiate Intellivision from Atari through sophistication and sports titles, and how to blunt Atari's advantage with arcade and space titles (figure 8.1). Scholars of this period have noted how "in the increasingly crowded and competitive market, diversification was necessary."[30] However, Intellivision's turn to space and arcade titles also reduced diversification in that the core themes of realism, sophistication, and intelligence—highlighted by Intellivision's realistic sports simulations—were increasingly neglected. The very qualities that were originally used to tout Intellivision's superiority to Atari were displaced.

Transformations in overlays illustrate this dynamic. For early strategy/action titles like *Sea Battle* and *Space Battle* (figure 2.9) and sports titles like

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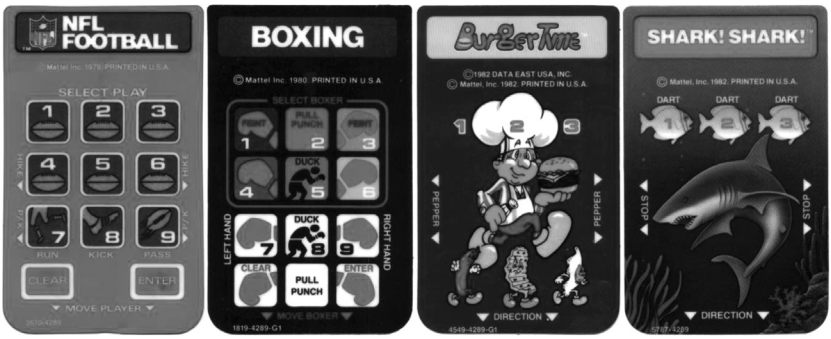

8.2 Overlays for *NFL Football*, *Boxing*, *BurgerTime*, and *Shark! Shark!*.

NFL Football and *Boxing* (figure 8.2), overlays provided information necessary to gameplay. Unless one had memorized the keypad operations, such videogames were unplayable without their overlays. But while some later titles made extensive use of the keypad (including *Utopia* and *Advanced Dungeons & Dragons*), most space and arcade titles used the keypad only for functions like setting the initial difficulty level. As a result, their overlays obscured the keypad with attractive art similar to that featured on the sides of arcade consoles or game boxes, as with *BurgerTime* and *Shark! Shark!* (figure 8.2). The function of overlays shifted to concealment, literally laying over what had been Intellivision's claim to distinction over Atari.

Mattel Electronics also shifted advertising to emphasize space and arcade games, often with television commercials featuring sports personality and author George Plimpton. Advertising ignited the boom with the Plimpton campaign during the 1980 Christmas season (chapter 4), and Plimpton remained a symbol of the boom, appearing in commercials throughout 1981 and 1982. A 1981 commercial for *Star Strike* featuring Plimpton compared it to Atari's *Asteroids*. Another Plimpton commercial highlighted *Space Battle*, *Space Armada*, and *Astrosmash*. Yet, for a later series of commercials, John Seifert (the account director for Intellivision at Ogilvy and Mather) signed a contract with Henry Thomas, the child actor star of *E.T. The Extra-Terrestrial* (1982). While Atari is infamous for its poorly designed *E.T.* game, it was Intellivision that paired Plimpton with Thomas.

One 1982 commercial featured Thomas with Plimpton. A giant neon sign spells "ARCADE" above a crowd of young adults, and the camera zooms in toward Plimpton, standing before a wall of televisions. As Plimpton begins to make an announcement, Thomas elbows his way through the teenagers and says, "Mr. Intellivision, how come all you ever talk about are sports games? Intellivision now has games like the arcade," naming *Lock 'n' Chase*,

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Tron Deadly Discs, and *Night Stalker*. Mattel Electronics iterated on its success with the Plimpton campaign throughout the boom, despite market research in May 1981 revealing that "viewers have low recall of Plimpton" and hinting at replacing him.[31] When Thomas greets Plimpton as "Mr. Intellivision," he simultaneously acknowledges Plimpton's association with Intellivision and Plimpton's fading importance as a sports personality.

While shifting to action and arcade videogames followed industry trends, it also meant struggling with Intellivision's technical limitations and increasing innovative use of the platform. *Space Armada* used GRAM sequencing (chapter 3) to animate hordes of descending aliens in the background graphics, overcoming Intellivision's eight-moving-object limitation. *Star Strike* used GRAM sequencing to create the illusion of a 3D trench speeding by—a feature amplified by a 1982 print advertisement that claimed playing *Star Strike* felt like your "living room is going 165 MPH." Creating this illusion was not easy, and *Star Strike* cycled many GRAM cards through sets of eight-card sequences to create the motion. This required bypassing the EXEC operating system (chapter 5) to communicate directly with GRAM, a practice that became more common during the boom. This was not just because programmers had become more savvy but because of a genre shift. The EXEC had been designed for sports and strategy, not fast-paced space and arcade games.

As consumer tastes drove a shift toward arcade conversions and action titles, more responsive controls became necessary. Mattel Electronics' first arcade conversion, *Lock 'n' Chase*, had controller issues that required fixing in mid-1982. Mattel programmer Julie Hoshizaki explained that the player-controlled thief would "get stuck when you're trying to turn. He would get stuck in the walls. So I had to make the controls a little smoother." After Hoshizaki's streamlining efforts, Quality Assurance employee Traci Glauser tested the game, writing that "thieves were not moving quick enough when turned. Now the thieves move a lot smoother and they respond to the disk better."[32] *BurgerTime*, in contrast, had extremely smooth controls for the chef character controlled by the player. This also required bypassing the EXEC, reading directly from the controller hardware ports sixty times a second (instead of the EXEC's twenty times a second) to provide the most accurate input. APh programmer Tom Loughry noted that twenty times a second "wasn't very fast. We were told from industry that human reaction time was a tenth of a second, so it didn't seem important, but that actually was not true. We started realizing in 1981, 'This is a serious limitation, not good enough for making a nice fast action game.' "

The smooth controls reflected programmer Ray Kaestner's unique approach to movement in *BurgerTime*. Specifically, players can move up

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and down on ladders and right or left on platforms, and direction changes occur at key decision points, rather than relying on collision detection to determine the chef's movement within the maze. Since the wheel on the controller can sense sixteen directions but only four directions are used in *BurgerTime*, multiple pressed directions can be condensed into one: for instance, if a player presses near the top of the disc, it still registers as "up." Thus, *BurgerTime* is forgiving and ultimately allows for smoother, more responsive control. *BurgerTime* even includes a routine, GUESS.DIR, to assist the player. A comment in the code reads, "If man is stopped and wheel is pressed . . . player probably is not aware that he is on wrong spot on the wheel, go guess what he really means." For example, a player on a ladder pushing a little too left (which is illegal movement on a ladder) might halt, so GUESS.DIR will check input, ascertain if they likely want to move up or down, and change the direction. This compensates for slightly mispressed commands, easing movement and producing more fluid control—ultimately resulting in quicker, uninterrupted action.

While pivoting to space and arcade games presented challenges that required innovative use of the platform, Intellivision games were still intended for the home and its longer horizons of gameplay. Space and arcade games thus iterated on the concept of a long-lasting play experience, a concept fundamental to Intellivision's philosophy from the beginning. At the time, some even bemoaned the length of games. Programmer William Fisher complained in a memo about being "bored" with Intellivision games: "*Deadly Discs*, *Space Hawk*, and *Space Spartans* take too long to play. . . . That's probably why arcade games are so popular—they're so much more difficult."[33] Fisher added, "What I'd like is a game that I can play in five minutes, no matter how good I am."[34] However, marketers wanted cartridges with play value that sustained user engagement. For example, since Intellivision's EXEC allowed selecting play speed by pressing 1, 2, 3, or the disc, players could tailor the difficulty of some arcade titles for the home. Even Intellivision's *Space Armada*, akin to *Space Invaders*, was modified for the home, offering a practice mode allowing players to replay the level that defeated them at a lower speed.

Ruminations about engaging, lasting play were codified in "What Do We Know about Software," an early metaanalysis of game design released internally in late 1982. In this report, Spitzer noted how "Intellivision owners . . . find their game satisfying over longer periods" when compared to Atari owners, and thus recommended design elements that would engage players.[35] For example, Spitzer developed the innovative concept of "plateaus of accomplishment" to explain how videogames should be designed to allow players to reach plateaus as they progressed, so that "after achieving

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a certain level . . . a portion of the game noticeably changes and the game increases in difficulty."[36] Spitzer argued that plateaus of accomplishment created a captivating, ambient awareness of progression and changes in difficulty.[37]

Spitzer provided several examples of plateaus of accomplishment, including *Astrosmash*, which marks them with different background colors. This title pioneered an approach to plateaus of accomplishment using simple dynamic difficulty adjustment. This design approach, influential in the contemporary period, involves monitoring player skill to automatically adjust the difficulty level. In *Astrosmash*, players gain points by shooting down meteors, UFOs, and other enemies, but lose points upon death or when rocks hit the ground. Difficulty increases across twenty score thresholds but can decrease if a player dies frequently and their score drops below a threshold. Sohl explained that *Astrosmash* embraced rising and falling moments of tension, likening the technique to a "James Bond movie" where the hero hangs from a building and "the evil guy is above him, stepping on fingers one at a time." Yet, the hero manages to recover and pull himself up. Because *Astrosmash* players get an extra life every one thousand points, the videogame's manual explained, "the game can go on for some time. If you want a break in the action, remember the 'Interrupt Code,'" reminding players of Intellivision's pause function.

Astrosmash highlighted how by the time of the boom, home systems were revealing new possibilities for game design. Arcade games could have plateaus of accomplishment (Spitzer offered *Donkey Kong* as an example) but combining them with dynamic difficulty adjustment was impractical given the economic need for short timeframes of gameplay. This indicates how Intellivision's move away from sports and toward space and arcade videogames did not mean the end of innovation. Even while increasingly de-emphasizing sophisticated titles that made full use of the complex hand controllers, Intellivision programmers, marketers, and executives were articulating design principles that shape videogames to this day.

From Esports to Espace

The shift from sports to space shifted promotional strategies as well. Marketers promoted Intellivision during the boom with "Intellivision Video-Challenge Tournaments," held in major cities and with an RCA projection television as the grand prize. These were publicized through local cosponsors and in Mattel Electronics' publication *Intellivision Game Club News*. This product-related fan magazine was yet another domain where Mattel had innovated years before: in 1961 *Barbie Magazine* "became an instant

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hit," leading to the Barbie Fan Club and an entire marketing universe of fandom.[38] *Intellivision Game Club News* reflected the broader emergence of videogame magazines like *Electronic Fun with Computers and Games* and *TV Gamer*, which instructed the player "in how to play, what to play, and what is cool (and not) in the game world."[39]

The inaugural issue of *Intellivision Game Club News* from autumn 1981 announced forthcoming Intellivision VideoChallenge Tournaments, alongside coverage of two baseball stars playing a "World Series in July" on Intellivision during the baseball strike that year. The connection of the VideoChallenge Tournaments to sports was reinforced by the fact that the first four tournaments (held in November and December 1981 in Baltimore, New York City, Philadelphia, and Washington) used *Auto Racing*, *Major League Baseball*, and *U.S. Ski Team Skiing*. Linking videogames to sports and player competition represents one of the earliest articulations of esports. This linkage did not just involve videogames with sports themes and competition but also corporate sponsorship and public tournaments with prizes and multiple rounds of competition, connecting videogames to themes of athletic play.

As Mattel Electronics shifted from sports to space, *Intellivision Game Club News* and the Videochallenge Tournaments followed suit. Early issues of *Intellivision Game Club News* prominently covered local "leagues" playing titles like *NFL Football* and *Bowling*, recalling neighborhood bowling, baseball teams, or even Superbowl parties of fans watching televised sports. This transitioned to recommendations that Intellivision owners host events like a "Space Action Party" featuring Intellivision space games, serving dishes like "*Star Strike* Pop Corn" and "*Space Battle* Burgers." Moreover, while the first four Videochallenge Tournaments focused on sports, the next tournament, in February 1982, included *Astrosmash* as one of three titles. The *Intellivision Game Club News* coverage of the event included an image of over fifty Intellivisions in a massive semicircle in a warehouse on Chicago's Navy Pier, with the caption "NASA Control or Intelligent Television?" Rather than the spectator watching televised sports at home, the association transferred to watching brilliant scientists and engineers, sitting at their consoles, launching rockets into space.

The extension of sports competition into the space genre was taken even further when the Videochallenge Tournaments were succeeded by the "$100,000 *Astrosmash* Shoot-Off," a five-month competition that included full-page advertisements in national magazines.[40] Between March and August 1982, about thirteen thousand participants sent photographs of their television screens showing peak *Astrosmash* scores; no other game was involved.[41] The plan was to select sixteen finalists, but an issue arose when

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the marketers realized that *Astrosmash* can be played at different skill levels. It was impossible to tell based on a photograph if someone had played at an easy or hard level: "There were reports of competitors who literally played for days at the slowest speed," pausing for sleep or to attend school.[42] The programmer Russ Haft recalled contestants "putting their machines in the refrigerator because the Intellivision notoriously overheated. If you wanted to have a high score, you had to play for days." Given these challenges, seventy-three entrants (rather than the planned sixteen) were flown to the competition on September 11 and 12.[43] The winner, eighteen-year-old Manuel Rodriguez from Stockton, California, received the $25,000 grand prize for a one-hour score of 835,180.[44]

The event was held at the Houston Astrodome, whose name was appropriately similar to "Astrosmash." Furthermore, the stadium was built for the baseball team the Houston Astros, linking sports to Houston's NASA Johnson Space Center. Participants in the Astrosmash Shoot-Off were called "video athletes," and those monitoring the event wore referee uniforms (figure 8.3). Charlene Margaritis, Director of Public Relations, recalled helping lead the contestants to a hotel near the stadium, where some asked, "'Why do the stairs keep moving?' and I thought, 'My goodness, some of these people have never seen an escalator before." Part of Margaritis's job was creating a positive image of Intellivision, which sometimes required countering negative impressions about videogames. She noted how the early 1980s "was just the beginning of kids not coming home after school and putting on their jeans and playing ball. It was a thing where they flopped on their couch and sat there." The Astrosmash Shoot-Off would not only promote Intellivision nationally but augment the legitimacy of playing videogames through association with the culturally valorized activity of professional sports.

This "Space Superbowl," as it was called, brought national visibility to what we would now call esports. Interweaving the genres of sports and space—through the fan magazine, Videochallenge Tournaments, and *Astrosmash* Shoot-off—transferred the cultural cache of competitive sports and sports spectatorship to videogaming, even to space and arcade videogames. Decades later, esports competitions would not orbit electronic versions of traditional sports—a more obvious evolution—but rather new competitive videogames from various genres. Intellivision facilitated public awareness of this transference. By modifying social contexts through competitions and fan materials, Intellivision offers a glimpse into the formation of early esports events and the social processes that augmented their cultural legitimacy.

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Space SUPERBOWL

Top guns score in Mattel's Astrosmash Shoot-Off

It was one of the most spectacular video game tournaments ever—the National Astrosmash Shootoff in Houston. After 13,000 people from the ages of 11 to 51 had sent Mattel photographs showing their top Astrosmash *scores, 16 of them were flown for a three-day trip to the Astrodome to test their skills for one hour . . . and $100,000 in prize money. According to Peter Pirner of Mattel, these video athletes "literally smashed their way through our game's computer programming." When the dust had cleared, 18-year-old Manuel Rodriguez from Stockton, California came out on top. Pictured here are some of the Astrosmash champions.*

Right, the world Astrosmash champion, Manuel Rodrigues. On the opposite page, bottom right, is second-prize winner ($12,500) Chuck Tappan of Elmira, New York. Above Chuck is the youngest of the finalists, 11-year-old Chad Junge of Arizona. To his left is fourth place finisher Byron Nelson.

8.3 "Space Superbowl: Top Guns Score in Mattel's Astrosmash Shoot-Off," *Electronic Fun with Computers and Games* 1, no. 2 (December 1982), 42.

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Intellivision's move into space and arcade videogames—genres considered Atari's home turf—demonstrates how the boom involved both innovating new genres for Intellivision and iterating industry norms. As it became clear that Intellivision would not dislodge Atari as best-selling console, Mattel Electronics executives considered making cartridges for their archrival. If Mattel Electronics could not easily extend Intellivision's market share, then Mattel Electronics would expand into Atari's. Mattel Electronics had already piggybacked off Atari's renown through their comparative advertisements (chapter 4), so why not piggyback off their technology as well? Atari's installed base of consoles was substantial, promising lucrative possibilities. This idea was an innovative business strategy produced through iteration—programmers did not need to imagine new games but would convert existing Intellivision titles. Such transplatform design and marketing, explored in chapter 12, carried significant peril. For example, since Atari already had the advantage of "more games," developing quality Atari titles would only increase their advantage (figure 8.1). However, with the boom underway, expansion and experimentation trumped caution and restraint.

Creating videogames for Atari was tricky. Frank O'Connell, Senior Vice President of Marketing, recalled Mattel's legal department saying, "'Look, Frank, Atari is suing everybody in sight who hasn't legitimately reverse engineered and documented the Atari system.'" With discretion in mind, O'Connell "went into the underground and let it be known I was looking for somebody who would legitimately develop and document it." Early in 1981, Richard Chang mentioned Mattel Electronics' interest in making Atari cartridges to APh's founder Glenn Hightower. Hightower offered to look into the matter for a price, but Mattel declined. Hightower forged ahead anyway. He quickly figured out how sound worked on the Atari, but the graphics were less obvious: "The whole idea of chasing the beam was so ridiculous and preposterous." Eventually, he used the Atari *Dragster* cartridge to reverse engineer the graphics capabilities because it "had a fancy screen." Hightower's efforts were predicated on a hunch that Mattel Electronics would not give up on the idea of making Atari cartridges. Indeed, in fall 1981 Mattel Electronics reached out again. Hightower met O'Connell at the local hotel Barnabey's, promising a lead.

A few days later, O'Connell received a phone call from someone representing a group with documented reverse engineering of the Atari system and a working cartridge. "They had it," O'Connell said, "I paid him a million bucks" and "we had what we needed."[45] This outside group, which went by the name Analemma, was represented at negotiations by the visual effects

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expert Ray Feeney (an associate of Hightower), who corresponded with Baum using a private home address in Pasadena.[46] With a contract in hand, work began on the project, with an initial goal of at least ten titles to be shown at the January 1982 CES.[47] These titles for the Atari console, sold by Mattel Electronics under the name M Network, were successful (with sales of around two hundred thousand each), and further development of such titles took place at APh and Mattel Electronics.[48]

The origins of M Network, where Mattel battled Atari on Atari's own turf, were complex and contentious. Keith Robinson, the Mattel programmer who chronicled Intellivision's story online, explained that "senior programmers took a leave of absence from APh" to work on M Network and were "paid directly by Hightower, not APh."[49] By the boom years, it was clear that Mattel Electronics was underpaying APh for the crucial labor it provided to develop videogames, and negotiating with Mattel through an outside group was a way for APh to capture more of the wealth that the boom was generating. APh programmer David Rolfe emphasized that M Network "was a super-crunch job, the highest priority stuff we'd ever been asked to do. We worked around the clock" and were told "there would be a huge windfall and we'd be heavily rewarded."[50] This eventually led to internal conflict at APh including disputes over payment for programming labor, thus revealing how the boom's chaotic growth could destabilize business and development practices. In a sense, Mattel Electronics was doing something similar as it rethought its rivalry with Atari—risking lawsuits as it hyperextended into Atari's domain. Boomtime was a period of risky, uncertain exploration but also explosive possibility.

The "New" Intellivision II

The move to space and arcade titles, as well as M Network, involved software responses to the boom. However, new hardware was needed as well. Since at least March 1981, Mattel Electronics, APh, and General Instrument (GI) leadership had been meeting formally to discuss next-generation systems. Ideas focused on an advanced system with completely new chips and architecture, an upgraded console that would be backward compatible, and a cost-reduced version of the original Master Component. Leadership in multiple companies navigated innovative or iterative options, debating which to pursue. In the spirit of hyperextension, Mattel Electronics pursued all three (chapter 13). Since the more innovative next-generation systems would not be ready quickly, Mattel's well-worn path of iteration would have to do. Given that the original console's price was understood to be the greatest barrier with regard to gaining market share against Atari, Mattel

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Electronics sought a cost-reduced Master Component that could be brought to market quickly. Soon after being hired in fall 1981, Prodromou (along with Denham, Barnes, and others) pursued such a console, codenamed "Big Mac" and released as Intellivision II. Despite its name, Intellivision II was not a new, successor console. It was still called the "Master Component" on its packaging, and it played old and new Intellivision cartridges. Intellivision II was an "advance" in that it reflected Mattel's longstanding mastery of cost-cutting and iteration around a successful pattern.

In January 1983, Mattel Electronics ran an advertisement stating consumers would soon be pleasantly surprised: "While others are introducing more expensive systems in a frantic effort to match our quality, we've kept our quality and reduced our price. Thanks to microtechnology, we've been able to drastically reduce the size and price of our Master Component."[51] Recalling the use of "SuperGraphics" to market Connie Goldman's craft rather than actual technological innovation (chapter 7), "microtechnology" was marketing jargon, used to obscure the fact that Intellivision II was essentially a smaller, cheaper Intellivision. Without a successor console ready for release and consoles like ColecoVision and the Atari 5200 appearing on the market, rejuvenating the original Intellivision with Intellivision II appeared novel without the challenge of developing radically new hardware. One marketer noted that when Mattel Electronics "came out with Intellivision II, the product was obsolete."[52]

However, Intellivision II delivered some minor technological changes. Prodromou had been hired to rectify problems with GI chip failures and shortages, and one way Mattel Electronics cut the cost of Intellivision II was by replacing some GI cartridge ROMs and Master Component chips with cheaper ROM chips from manufacturers like Toshiba. Other changes included making the power supply and hand controllers detachable (both were hardwired into the original Intellivision, with high failure rates). Additionally, external video output was added for the System Changer, an extension that would play Atari cartridges (chapter 12).[53] Inside, Intellivision II's EXEC operating system contained minor changes, including a copyright lockout check to deter third-party developers.

Since this was to be sold as Intellivision II, the Master Component would require a new look. Prodromou and Barnes passed this task to the Visual Designer Ted Mayer, who recalled asking, "'What's different about Intellivision II?' And they said, 'Oh, nothing. It's just smaller and more compact.'" Mayer, who had joined Mattel Toys in 1977, responded that the new console should make a statement: "I said, 'The toy industry, it's a fashion industry. Every year you have to have something new to grab you.' They didn't see that. These were people from Texas Instruments that were not

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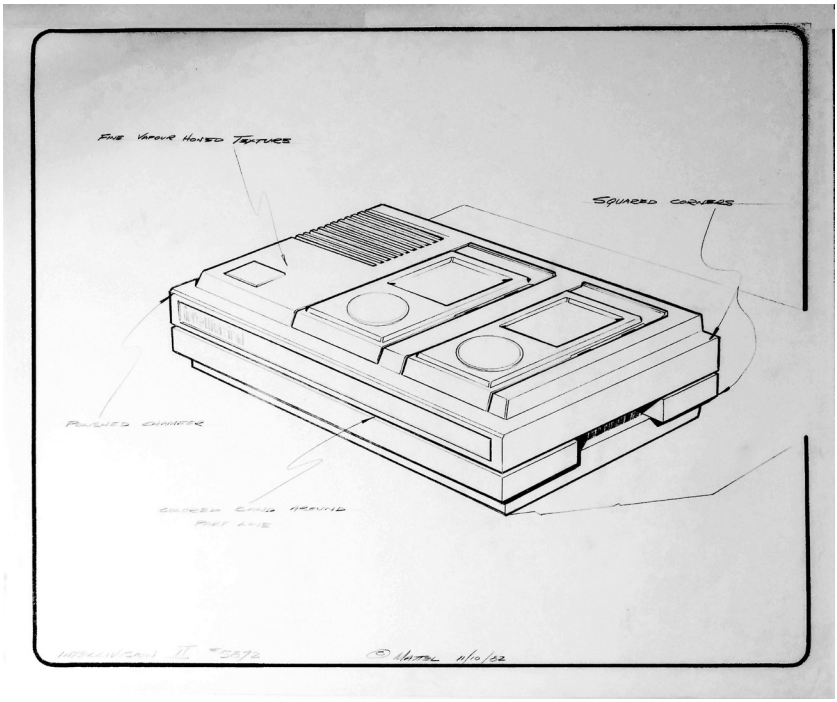

8.4 Ted Mayer's final design for Intellivision II.

in the same world as a toy company." Mayer was given freedom within cost constraints, but he recalled that "they really didn't care what it looked like. They just wanted the guts."

The original Intellivision design took cues from home appliances—wood paneling, dark brown colors, curved surfaces. Free to reimagine Intellivision II's design, and given that Intellivision had been envisioned since its inception as a modular and expandable system akin to stereos, Mayer turned to the world of consumer electronics. Mayer noted that "Sony was the up-and-coming thing. And that red stripe around Intellivision II? Sony used to put little red borders on things and that's where that came from." This was the core of the finalized Intellivision II design (figure 8.4). Mayer noted that he worked toward a design that cut tooling costs in half because "we were told even half a penny makes a big difference." The Staff Industrial Engineer Linda Bruce recalled working with Mayer and Design Engineer Mark DiCamillo to develop new methods for less expensive assembly. For instance, DiCamillo noted how Intellivision II incorporated plastic hinges that snapped together at the back, reducing the number of screws needed to

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8.5 Intellivision II as released (image from the 1983 Mattel Electronics Canada catalog).

attach the base to the cover from four to two. "The form factor for the original Intellivision just was massive," DiCamillo added, "We were trying to get sleeker, smaller. It didn't have to be that big for the electronics inside."

Intellivision II went into production in October 1982 and was released in early 1983 (figure 8.5).[54] Unlike the original Master Component and Keyboard Component, there was no period of test marketing prior to full retail release. This reflects the hyperextension of the boom period. The sense of urgency to get products to market was so strong that longstanding procedures for assessing consumer interest and testing were set aside. As a result, Intellivision II suffered quality problems, including its flat membrane keypad that did not offer a tactile response like the original bubble keypad. The side buttons had less travel. The Systems Group engineer Ray Roux found them hard to press but recalled the hardware engineers' response "was something to the effect of, "We don't care.'"[55] Marketing research confirmed that "consumers found Intellivision II's side firing buttons substantially less appealing than those of the original Intellivision."[56]

Despite these challenges, Intellivision II succeeded in areas where the original console faltered. Prodromou noted that while the original console had slim profit margins, a high failure rate, and suffered from manufacturing bottlenecks, for a time Intellivision II was "much more reliable, didn't overheat, and we could supply substantial volumes." Because Intellivision II

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appeared on the market in 1983 when Mattel Electronics was struggling and the market crash had begun, it would prove to be too little, too late.

Intellivision II was emblematic of Mattel Electronics' contradictions during the boom. On the one hand, its development reflected the desire to expand, extend, innovate, and differentiate. On the other, it encapsulated a turn to iterative processes like cost reduction, streamlining technology, and marketing that peddled the old in the guise of the new. Boomtime for Mattel Electronics required the navigation of these simultaneous possibilities, hyperextending and "expanding as fast as we can," as Denham said, while iterating and responding to shifts in the industry. Ultimately, the boom's force was channeled through a logic of extension. The boom accelerated Mattel Electronics' expansion and separation from the Toy division. It extended Intellivision game development from sports themes into space and arcade titles. The central rivalry with Atari drove Mattel Electronics to expand into Atari's domain, producing games for its main competitor's platform, and it also motivated the cheaper Intellivision II. In part III, we will examine specific hardware extensions as well as emergent transplatform relationships with Atari and other systems—thus further exploring the logic of extension that was fundamental to Intellivision's identity.

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Extensions

III

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Intellivoice

9

Major League Baseball was programmed at APh by David Rolfe while he was developing Intellivision's operating system. The game became famous for its umpire shouting "you're out," accompanied by the text YER OUT! on screen. Hal Finney, another APh programmer, was experimenting to see if Intellivision's sound chip could generate speech within its limited parameters. Rolfe recalled that "I happened to walk by and he said, 'Dave, listen to this: What does it sound like?' He'd been trying to approximate cycling through the vowels. I heard his A-E-I-O-U as 'yer out' and I got very excited."[1] At Rolfe's request, Finney modified the code to add a "t" sound at the end. While a one-time technological sleight of hand, YER OUT! reveals how the desire to synthesize speech dated to Intellivision's beginnings. This desire lay behind Intellivoice, an extension that plugged into the Master Component.

Before Intellivision was released it was conceived as a modular system, with the Keyboard Component promising to turn Intellivision into a home computer (chapter 3). As we have argued throughout this book, modular extensibility was a framework by which videogame platforms were understood as systems during the second generation, their cartridge ports opening into a future of possibility. For Mattel Electronics executives, engineers, and marketers, modular extensibility became crucial—a way to add play value to the system, pursue profits, and differentiate Intellivision from the Atari VCS in the marketplace. The success of the Master Component led to hyperextension, described in the last chapter, a condition of rapid expansion partially driven by pursuing hardware extensions and even successor

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systems imagined to re-create Intellivision's modular extensibility for the next generation. In part III of this book, we explore how different extensions such as Intellivoice transformed Intellivision's games and play experiences, and how they significantly altered Mattel Electronics' business and organization. Conceptually, "extension" provides a framework to understand the second generation and Intellivision in particular, leading to the emergence of transplatform relations and conditions of overextension that we explore in the closing chapters.

For the videogame consumer considering an extension for Intellivision, one would likely have come to mind: Intellivoice, Intellivision's best-known and best-selling add-on, released in 1982. Mattel's long history with talking toys, such as the Chatty Dolls, made this extension familiar to leadership. Moreover, digital speech was already being used in toys like Texas Instrument's popular Speak & Spell. Unlike the faked YER OUT! or the digital speech available on the market, Mattel Electronics engineers pursued higher quality through realistic voice synthesis—an extension of Mattel's history of linking realism with quality. As one Mattel Electronics catalog explained, the voices were "not fuzzy simulations, but voices complete with expression, produced by the ability of Intellivoice to duplicate realistic human speech electronically." In a sense, Intellivoice was the aural analogue to Intellivision's "running man" animation, which exemplified Intellivision's realism by simulating fluid human movement. Intellivoice "animated" voice like the Master Component animated the body.

Intellivoice was ambitious in its approach, which merged digital voice synthesis and prerecorded human speech. Unlike the Keyboard Component with cassettes containing an analog audio track for recorded voice, Intellivoice synthesized speech based on voice data recorded digitally. Thus, as the back of the add-on's box proclaimed, Intellivoice videogames did not just "play back" recorded speech. Intellivoice's realism lay in combining professional voice actors, top-notch recording and encoding, and a digital model of the vocal tract to synthesize high-quality speech. This was a digital realism of the throat, speaking to Intellivision's broader vision of intelligence and the human.

"Mattel Electronics Presents . . ."

Intellivoice emerged in part because of Mattel's relationship with General Instrument (GI), where a team led by Philip McLaughlin had developed the SP0256 Speech Processor. This chip contained "internal ROM encoded speech segments, referred to as 'Resident Code'" or RESROM (for Resident

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ROM).[2] The chip could also generate speech from nonresident voice ROM on a cartridge. The chip's digital "Vocal Tract Model" used 17 parameters to generate speech from RESROM and cartridge ROM data.[3] GI sought buyers for its chip, and variants were produced like Radio Shack's SP0256-AL2 and the SP0256-019 for Magnavox Odyssey[2]'s "The Voice" extension.[4] Stephen Maine, an engineer at GI, noted that Intellivoice emerged almost as an "afterthought" because GI and Mattel were mutually interested.

Market pressures also stimulated interest. At the January 1981 Consumer Electronics Show (CES), the toy company Mego, which had made a few handheld games, touted an upcoming "Video Voice System" featuring a "built-in voice synthesis chip."[5] Mattel President Bob Anderson attended this CES, collecting a Mego advertisement with a comparison chart showing that its unreleased system had voice synthesis but Intellivision did not. A few days later, Anderson asked Ray Wagner (President of Mattel Toys) and Josh Denham (President of Mattel Electronics) to "discuss our plans for developing our capability in this area at an early date."[6] Scrawled on the memo was a note: "Tell D. Chandler to see me on this ASAP."

David Chandler, who was directing Intellivision development, also managed most hardware extensions, and work was already well underway on Intellivoice. For this same January 1981 CES, the programmer Brian Dougherty had been tasked with creating a "proof of concept" for voice. Dougherty decided to modify the existing *Las Vegas Poker & Blackjack* cartridge to have "the blackjack dealer talk to you as you were playing, and he had a Humphrey Bogart-like accent" so "when you're busted he'd say, 'Sorry, sweetheart.'" But Chandler thought such speech was unnecessary when it was already obvious the round was lost. When Chandler responded to Anderson with a presentation on voice, he emphasized that "voice needs to add lasting value to programs. CES version of Blackjack [is] great for demonstration but probably not suitable for sale."[7] Chandler's notion of "lasting value" recalls Mattel's core notion of play value (chapter 4), meaning that voice should augment gameplay. Voice should not just add "color," marketing demanded, but a voice cartridge should be unplayable with the sound off. This meant that Intellivoice cartridges could not be released as non-voice titles for the Master Component. In theory, software could drive hardware sales.

Engineers at Mattel Electronics led by Ron Carlson worked with the GI team to develop an extension incorporating a variant of the SP0256.[8] The final design had three primary components. First, at Intellivoice's heart was the SP0256-012, custom designed with a RESROM that included a male voice speaking words and phrases such as numbers, "press" and "enter," directions like "up" and "down," and "Mattel Electronics Presents."[9] Second,

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there was an audio filter and amplifier that changed the digital output of the SP0256-012 to an analog signal.[10] Third, a SPB-640 buffer/interface chip, initially designed by Dougherty, transmitted RESROM and cartridge voice data to the speech chip for processing and then to the Master Component.

Radio Shack's SP0256-AL2 included a library of smaller discrete speech units, termed "allophones," that could be used to generate speech.[11] However, Intellivoice did not include such a library, since its robotic-sounding output interfered with the desired goals of quality and realism. The ROMs used with Intellivoice's speech chip were partitioned into speech segments, which might store discrete speech sounds, words, or short phrases. The segment data on the ROMs included encoded parameters such as pitch, amplitude, voiced or unvoiced status, and other filter information that a microcontroller on the chip would process and send to the Vocal Tract Model for output. This data was obtained and adjusted through sound processing techniques prior to being encoded on the ROMs.

In August 1981, around the time Dougherty left Mattel Electronics to cofound Imagic, Thom Randolph was hired as a Systems Design Engineer—becoming, as he put it, the "spec monkey" completing work on Intellivoice's buffer chip. This chip connected Intellivoice to the Master Component. In theory, extensions connected to Intellivoice could interface with the Master Component as well. In fact, Chandler had considered GI's recommendation to place the speech chip on cartridges instead of creating a hardware extension, but one of the highlighted benefits of the latter was "expansion capability" for peripherals.[12] Chandler found this attractive, proposing a "stacking connector" port on top of the Intellivoice and suggesting possibilities such as remote hand controllers and an extension for "home banking"—hardly a typical use of a videogame console.[13]

The modular vision of Intellivision as extending into the world of home computing was shaping hardware design. As with the Keyboard Component, Chandler pushed this vision despite the technical and budgetary challenges it created. Randolph recalled telling Chandler to abandon the stacking connector, explaining that its port would render the Intellivoice useless if plugged in incorrectly and that it added 15 percent to the cost of the upper molding. It also endangered emissions certification. Randolph emphasized that the Federal Communications Commission (FCC) required that the Master Component be tested with Intellivoice, and the stacking connector "amounts basically to an antenna" releasing electrical emissions from the system. Despite such warnings, the stacking connector was included, even though it was never used. It remained a sealed brown rectangle on Intellivoice's top, a vestigial sign of Mattel Electronics' embrace of modular extensibility and Chandler's vision for the platform futures of Intellivision.

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As the extension took form, the Staff Industrial Engineer Linda Bruce noted team members "were all very proud of Intellivoice because it was something different. Something that the rest of the industry didn't have." Yet this market lead was fragile, and Chandler's response to Anderson was marked by a sense of urgency. Chandler warned that Mattel Electronics had the "best speech quality around, due in large part to Ron Carlson's involvement in the speech encoding process," but "we are educating GI who can then provide better speech quality to our competition." The concern made sense given that the Odyssey[2] and other systems were using variants of GI's SP0256 chip. Chandler concluded that "our quality lead is volatile; we need to move ahead to capitalize on that lead."[14] He argued that to retain this lead, Mattel needed to streamline speech encoding and develop its own in-house voice facilities.[15] Thus, attention turned to how voice would be integrated into videogames.

Making Intellivoice Speak

Making Intellivoice speak centered voice in game design. The development process was challenging because as Keith Robinson noted in a guide for programmers, "the programming of a voice game and the generating of its voice data occur simultaneously. Early in the development of the game, the programmer sits down with a writer and together they work out the voice script. Then, while the programmer codes the game, the voice is recorded, digitized, and edited."[16] This approach, with its writers and scripts invoking Southern California's entertainment industry, involved professional actors and speech specialists. Applications Software programmers therefore coordinated with two other departments, Creative Media and Voice Products.

The first step involved Creative Media staff writing a working script to be finalized with the programmer. This identified what words and short phrases (rarely more than five words long) would be used and for what purposes—a crucial step since most games contained between twenty-five and thirty-five words. Although the SP0256 could synthesize voice at the phonemic level, Robinson warned that "building sentences from words and words from syllables often leads to choppy, unnatural sounding results, especially if the words are read with any emotion."[17] Reusing words and even smaller sound units to assemble speech could betray Intellivoice's goals of quality and realism.

The key dynamics shaping Intellivoice game design included the tension between the goals of quality and realism, and the computational constraint of cartridge space. The Keyboard Component's cassette tape drive made voice-dominant titles like *Conversational French* possible, but Intellivoice

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did not use cassettes. Any cartridge memory used for voice data meant less space for gameplay and graphics code. Robinson summed up the problem by stating that "voice code eats up decles more than anything else in Intellivision programming."[18] The programmer William Fisher emphasized that "the audio data was huge. If you could cut a single word out of the phrasing, you'd save enough space to add a feature or two to the game." Almost half of *Space Spartans*'s 8KD cartridge was dedicated to voice data. Subsequent Intellivoice videogames were 12KD, but voice still imposed extreme constraints. For instance, the thirty-five words used in *Tron Solar Sailer* outside of RESROM took up 4.8KD of its 12KD cartridge.[19]

GI's SP0256 was designed to "trade off speech quality for vocabulary size when it is desirable to do so," and a range of "bit reduction techniques" were used to grapple with memory limitations.[20] Joey Silvian, Manager of Creative Media, recalled how sound editors tested to see if 90 percent of the audio data was removed, would you still "recognize that it was a word that you knew?" For instance, during work on the unreleased "Space Shuttle" cartridge, the speech editors wrote "bit hunt" on design documents to note how tweaking the voice parameters allowed reducing the phrase "we have" from 1,186 to 1,110 bits.[21] As a principle, Robinson advised, "Avoid difficult sounds. Certain sound combinations—SH, NG, SP, ZZ—are hard to digitize. They have to be done at a higher bit rate which will eat up more decles."[22] While voice design worked primarily at the level of words and short phrases, computational constraint forced programmers and designers to consider individual sounds. Memory was at such a premium that voice encoders would change sampling rates within a word.[23] For the alien commander's voice that says, "The battle is over" in *Space Spartans*, Fisher recalled, "that was absolutely mercilessly flogged to death by the audio engineers to get that as low as possible."[24] This use of a robotic-sounding voice reflected both computational affordances of memory and considerations of game design. In this case, compromising audio quality made sense thematically.

Reducing vocabulary was crucial to saving space. Voice Products speech editors would conduct a syllable and word count of the script and look for "possible synthesis problems."[25] As noted before, building phrases from individual words ran the risk of losing realism and emotion, and so it had to be done with care. The engineers would generate a "syntax diagram" to clarify how this worked in any particular videogame. For instance, in "Space Shuttle," "abort" could be followed by "launch" or "mission."[26] The team working on *B-17 Bomber* sought phrases like "watch out for flak." Fisher emphasized that "you can either say 'watch for flak' or 'flak, flak' or 'flak, watch for flak.' That was a lot of fun, trying to figure out how to shoehorn

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the maximum number of sentences into the minimum number of pieces of unique audio." Another option was to record cartridge ROM voice that closely matched the male voice in Intellivoice's onboard RESROM. The word "aliens" in *Space Spartans*' cartridge ROM was sufficiently similar to the spoken numbers stored in RESROM that they could be combined to produce phrases like "thirty-four aliens."[27]

Based on their experience developing working scripts, Voice Products generalized eight functions of voice: warning ("12 minutes 'til blast"), action ("take a drink"), sequence of actions ("cut this first"), reinforcement ("good going"), location ("target in sight"), color ("bombs away"), status ("hyperdrive on"), and challenge ("they'll never do it in time").[28] For instance, *Space Spartans* had four voices, even listed in the manual: the "central computer" announcing your ship's energy level and the number of nearby enemies (warning, status); the "ship's computer" conveying the condition of ship systems (status); the "starbase computer" alerting of attack (warning, location); and the "alien commander" saying "the battle is over" (status, color). This generalization of voice functions represents an early typology of narrative action that impacted gameplay. Indeed, the programmer Karen Tanouye (later McConathy) noted that voice changed the tempo of videogames (including her unreleased "Woody Woodpecker"), because "the action would stop so you could hear what was being said. So the gameplay was slower than it would have been if it wasn't a voice game." The functions of voice developed by Voice Products helped navigate these changing dynamics.

Once a script was finalized, "studio auditions are held for as many as 30 people before being narrowed down to two or three acceptable candidates."[29] Silvian would direct recording sessions with the chosen voice actors, which would take three to four hours (the goal was "at least two takes everyone is happy with").[30] Silvian recalled, "I was in a recording studio in Hollywood for it seemed like a year straight." Reflecting the influence of Southern California, most sessions occurred at Fred Jones Recording Services, and voice actors often came from the large pool of local talent. For instance, three of the four founding members of the Firesign Theatre comedy troupe provided voice for Intellivoice titles, including Phil Proctor (*B-17 Bomber*, *Bomb Squad*), who voiced parts in the movies *Toy Story* and *Monsters, Inc*.[31] Other talent included Keri Tombazian (*Space Spartans*), who later worked on the videogame *Red Dead Redemption II*, and Cory Burton (*Tron Solar Sailer*), the voice of Zeus in the videogame *God of War* and Count Dooku in the series *Star Wars: The Clone Wars*. Given the quality of digital audio at the time (details of individual voices were difficult to discern), and

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since these actors were never mentioned in advertising or manuals, the effort expended in securing and recording anonymized Hollywood talent indicates the importance attached to voice as a feature that could make videogames intelligent, realistic, and distinctive.

The next steps were to break the recording into speech segments, encode these segments into a form that the SP0256 could process, store the data in the cartridge, and then integrate the game and speech code.[32] The skills of professional voice actors extended to this stage. As Randolph emphasized, "One of their talents is that they speak consistently, so their speech can be better segmented and put back together, without requiring 45 different 's' or 'th' sounds."[33] The encoding process was extremely important, requiring editors to process recordings to create data that the SP0256 could use. At this stage, engineers tirelessly tested speech segments, adjusting parameters and massaging data to reduce glitches and unintelligible audio while attempting to retain the distinctive character of the recorded voices. A memo detailing their process revealed their ambitions: "We will direct our efforts toward best quality speech. We want to have high intelligibility with the least synthetic affects [sic] possible."[34] They did not want baseline intelligibility, but the best quality, key to an aesthetic of realism.

This sound engineering work was so complex that originally, as McLaughlin noted, GI's voice lab in New York was "the only facility in the world at the time that was able to compress such material into the tiny ROM space available and still retain the distinctive performances of the voice artists."[35] As a result, the voice for *Space Spartans* and *B-17 Bomber* was "produced by shuttle flights to New York."[36] Fisher recalled working through the night because the lab was being used during the day. To avoid this time-consuming bicoastal workflow, Mattel Electronics built its own "state-of-the-art voice lab" in Hawthorne.[37] *Bomb Squad* became the first Intellivoice game produced entirely in California, followed by *Tron Solar Sailer*, *World Series Major League Baseball*, and around five unreleased titles, including "Space Shuttle."[38]

After sound engineering, the Voice Products group would conduct perceptual testing. This involved a nine-part questionnaire that included "Did any of the lines sound especially awful?" and "Did you notice any particular emotional quality in any character voice?"[39] For instance, the results of thirteen listeners for "Space Shuttle" found that "about 2/3 of the words scored 100% recognition" but some had recognition levels as low as 69 percent; it also found that "the distinction between the two male voices was largely lost."[40] This was a concern: no Intellivoice title had only one voice, and some had as many as six. One aspect of Intellivoice that distinguished it from other voice technology like the Odyssey^2's The Voice was that it created a

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sense of realism through multiple voices that could be distinguished from each other.

Perceptual testing was the voice equivalent to debugging, but unlike bugs in code that could cause a crash, perceptual testing involved human recognition and trafficked in percentages.[41] It was a relative assessment with the goal of the best possible intelligibility given memory limits. For example, in *Tron Solar Sailer*, the word "sector" sounds similar to "vector," revealing that ambiguities could remain in cartridges. Based on the results, words might be rerecorded or individual sounds adjusted to improve intelligibility. With regard to the phrase "ignite engines" in "Space Shuttle," perceptual testing found "the final s is not heard . . . we might try to boost the final frication."[42]

Making Intellivoice speak was an extraordinarily complex process, involving detailed coordination, planning, and forms of linguistic and dramatic expertise far outside Mattel Electronics' original focus on game programming. This process illustrates how videogame platforms extend into the material world beyond software and hardware. One cannot understand the incorporation of voice into Intellivision games by simply looking at code or chips—it requires ways of knowing the material "platform" of language and interweaving computation, linguistic expertise, and artistic performance. Such a perspective broadens platform studies, requiring the examination of transplatform relations emerging between socio-technical systems and the practices that such relations evolve.

Ultimately, Mattel Electronics staff went to extreme lengths to capture real voices—hiring actors, building a state-of-the-art studio, and employing teams of speech experts to encode the voice data—because Intellivision's intelligence was manifested through realism. Mattel Electronics leadership eschewed the generation of speech from phonetic structures because what mattered was that Intellivoice synthesized the voices of specific human beings. Yet the speech was also not a mere recording. It was the real-time generation of speech using a simulated vocal tract. In other words, Intellivoice demonstrated that Intellivision technology could not just speak but speak intelligibly in multiple voices. "Intelligence" and "intelligible" share a common root, and for Intellivoice it was above all the quality integration of human and technological speech that made Intellivision's promise of realism and intelligence intelligible.

Translating Voices

Speech is a universal feature of human community, but it is always culturally specific. No one speaks "language." We speak particular languages, and

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the vocal tract is always specifically embodied. Intellivision games sold in Europe, Australia, or Japan were normally left unchanged, with only boxes and manuals translated. However, the conceit of Intellivoice was that voice was necessary to gameplay. For instance, at the start of "Phase I" gameplay in *Tron Solar Sailer*, one must enter a five-digit access code that is only spoken. The necessity of voice to gameplay meant Intellivoice's speech would need to be translated for international markets. Intellivoice thus was an early example of videogame localization. An international version of the extension was prototyped with French, German, and Italian versions of the RESROM. To produce French, German, and Italian recordings for *Bomb Squad*, *Tron Solar Sailer*, and *Space Spartans*, Silvian traveled to Italy and France and coordinated with Mattel's regional office in Germany.[43]

Issues of translation arose. For the German version of *Space Spartans*, Silvian's team proposed translating "repairs off" and "repairs on" as "reparatur aus" and "reparatur an," and using "Das Spiel ist Aus" for "the battle is over." Staff at Mattel's Germany office rejected "reparatur aus" and "reparatur an," suggesting instead "reparatur beendet" and "reparatur begonnen."[44] Gabriel Baum, Vice President of Applications Software, responded that "we are using 'an' and 'aus' because we already have those words in the game. The addition of the other terms . . . although more correct, would create a problem in terms of limited computer word storage space."[45]

Cartridge memory constraints were affecting translation, but this was not the only factor. For instance, the Germany staff rejected "Das Spiel ist Aus" not to save space but because it was "the German title of a drama by Sartre."[46] These examples show the important role of local staff. Silvian noted, "There were cultural things that determined what a funny voice would be and the studio guys in France, Italy and Germany knew what those were." Issues of language extended beyond lexicon: for instance, in German the syntax for numbers is "three and twenty" rather than "twenty-three," and the programmer Stephen Roney recalled reworking the German version of *Space Spartans* to reflect this.

Intellivoice illustrates how technological and cultural elements imbricated to shape game design. Dominant social ideas become embedded in technology, giving rise to a series of critical questions. Voice Product engineers used a "generated model of 'ideal' speech" that was shaped by cultural assumptions as well as technology, searching for "synthesizable" voices and using their knowledge of the technical affordances of the speech chip to deem voices "acceptable" in terms of "the speaker's character, vocal quality, and pronunciation."[47] Robinson's Intellivoice design guide advised, "Avoid difficult voices. Female voices and voices with heavy accents have to be done at higher bit rates to be clear. It's often best to reserve these voices for the

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'colorful' phrases (e.g., Boris's taunting in *Bomb Squad*) and have the bulk of the essential phrases done with plain male voices."[48]

The idea that difficult voices, identified as female or accented, should be avoided or treated as nonessential color marginalized them within a technical space where plain male voices operate as the essential norm. Robinson's guide warned that a female voice "could use nearly twice as many decles to say a word as a male voice," adding that Intellivoice's SP0256 chip was built to synthesize a standard male voice and was "not designed to reproduce southern accents, female voices, or Woody Woodpecker's laugh."[49] The chip used a Linear Predictive Coding method for speech synthesis: as some studies showed at the the time, when using this method, "Intelligibility was higher for male speakers than female speakers."[50] The chip's design reflects how technology constrained representation but also how norms and priorities around representation shaped technology. Fisher noted that for *Space Spartans*, programmers used a higher-pitched female voice for the ship's computer but due to space limits, "we made the [central computer] a male voice." However, women's voices did not consume more memory simply by chance. Not only do the pitches of women and men overlap, but because Intellivoice's RESROM included only a male voice, it privileged male speech.[51] Idealized female voices might have consumed more decles, but they also could not be paired with RESROM voice, thus further limiting their use. In fact, of the four Intellivoice games released, two had no female voice at all, and two (*Space Spartans* and *Tron Solar Sailer*) had one female voice alongside multiple male voices. For *Tron Solar Sailer*, recording the numbers "zero" through "seven" in the female voice used up eight of the thirty-five words contained in the cartridge.[52]

The gendering of the RESROM voice and recommending avoiding female and accented voices both occur under the guise of technical neutrality but involve deeper issues regarding how cultural hierarchies are embedded into technology. When communicating with Italian staff, Baum asked for the "audition of at least 12 females to play the part of the female computer—These women need to be clear speakers who talk without gravel (hoarseness) or breathiness and who have flexible voices so we can get them to sound sexy."[53] Despite the cost of including the female voice when memory space was limited, they still did so. This gendering of the computer's voice extends a long history of feminizing technology as an object of heterosexual desire, and the computational constraint of cartridge memory was negotiated in terms of socially constructed gender norms.[54] Intellivoice's legacy includes not just sophisticated integration of speech into videogames but the technological encoding of social inequality.

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Because it sold more widely than any other extension, Intellivoice exemplifies the tension between hardware and software during the second generation. As Roney emphasized, a crucial issue was that for Intellivoice to generate revenue, there needed to be multiple games that required it from the outset, a fact that required shifting programmer resources to Intellivoice production. In addition to the hope of generating profits with new hardware and software sales, Intellivoice was intended to augment Intellivision's brand of intelligence and sophistication, differentiating Intellivision from rivals to drive console sales. Once *Space Spartans*, *B-17 Bomber*, and *Bomb Squad* were released, Mattel Electronics worked with the advertising agency Ogilvy & Mather to promote the extension. This included a commercial with George Plimpton once again comparing Intellivision with Atari—in this case, placing a hand over the camera so one hears Atari gameplay sounds compared to voices from *Space Spartans*. "The battle is over," says Intellivoice, which in this context suggests Atari's defeat.

Yet Intellivoice was developed without first establishing consumer interest. Market research had suggested that a "packet" of Intellivoice with one cartridge should retail at $120.[55] This price dropped almost as soon as the extension was released in fall 1982. By October, Intellivoice had been reduced to $60 in some markets.[56] Despite these discounts, Gary Elliot, Vice President for Software Advertising at Ogilvy and Mather, noted that Intellivoice "soon fizzled." While speech in videogames seemed like a technological marvel, market research investigating the extension's poor sales concluded that voice "is not a factor of major importance in videogame selection."[57] Intellivoice was eventually offered for free with purchase of a Master Component or two Intellivoice cartridges.[58]

Even before Intellivoice was canceled in August 1983, it was struggling to the point that its original motivation had largely been abandoned. As noted earlier, Chandler's vision of lasting value for Intellivoice titles meant that voice should be integral to gameplay. However, this was relaxed in the face of poor sales. In an April 1983 memo, the programmer and manager Don Daglow announced that "the voice unit is our most poorly supported hardware" and prioritized titles "with voice either as an integral part of the game play or for 'incidental color.'"[59] When asked in early 1983 to design a new *Dungeons & Dragons* videogame, for example, the programmer Daniel Bass was told it should be "voice-optional," meaning that it also could be played on the Master Component alone.[60]

Despite its eventual demise, Intellivoice exemplified themes central to Intellivision's significance. It was Intellivision's most well-known

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extension and forwarded the vision of modular extensibility embraced by Mattel Electronics leadership. Responding to anxiety that competitors were on the verge of releasing voice videogames, it was a strategy to differentiate Intellivision from Atari and other rivals. Most importantly, Intellivoice augmented Intellivision's connection to realism and intelligence. In this framework, to be intelligent is to speak intelligibly. For Intellivision, intelligence was more than a marketing strategy. It was a pervasive cultural logic. Intellivoice extended this logic, teaching consumers to associate intelligence with Intellivision and with videogames, computerization, and technology itself.

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The ECS

10

It's October 29, 1982, and "Scottsdale" is underway. At the McCormack Ranch resort in Scottsdale, Arizona, Mattel Electronics is holding a major event to preview the upcoming year's product line for retail and wholesale buyers. Programmer and manager Don Daglow recalled how "they broke us up, flying on different planes so no one plane crash could take out the company."[1] Teams from every corner of Mattel Electronics have been scrambling to prepare for this event, but one team is particularly excited: the Entertainment Computer System (ECS) marketing group, headed by Gary Moskovitz. "This was our coming-out party," Moskovitz noted, recalling how the ECS team worked feverishly to assemble a working prototype. "We felt that we were going to be the stars of this particular show," Moskovitz added, and they were. At the event's opening night, Mattel Electronics President Josh Denham gave a keynote address praising the ECS group for their work. The room broke out in applause: "We stood up and my boss, Pete Pirner, kissed me in front of everybody."[2]

The ECS was a computer add-on that expanded Intellivision's Master Component. It was a relatively inexpensive extension designed to replace the troubled, pricey Keyboard Component which we discussed in chapter 3. Its added sound, memory, input, and storage capabilities required attention to new constraints and affordances. It required funding, labor, and software development, contributing to the overextension that burdened Mattel Electronics during the crash of the US videogame industry in 1983. Although it was not released until shortly before Mattel Electronics shuttered, it foregrounded a vision for a computer add-on that augmented videogames,

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emphasized computing as fun, and returned to the idea of Intellivision extending Mattel's history as a toy company.[3] Moskovitz promoted the ECS as fitting "right between video games that compute and computers that play video games."[4] It was neither videogame machine nor computer but a unique extension that allowed users to toy around with games.

From the Keyboard Component to the ECS

The development of the ECS was an important moment in the tensions between competing visions for Intellivision. This tension played out between the figures of David Chandler, by this point Vice President of Strategic Development, and Richard Chang, by this point Vice President of Design and Development. Had the Keyboard Component been a success, the ECS might never have existed. It was born from the death pangs of the Keyboard Component, which Chandler was having trouble bringing to market. As the Keyboard Component's problems mounted in 1980 and 1981, Moskovitz recalled a growing impression that it "had turned into a fiasco." There were technical issues with manufacturing and reliability, costs were high, and barely any software was ready for sale when it was test marketed.

Given these issues, Mattel Electronics explored bringing a simpler keyboard extension to market. A group under Chang, including the engineers Jan Chodak and Greg Goodknight, began developing a lower-cost extension named the BASIC Discovery System (BDS), centered on the BASIC programming language for "computer novices."[5] Brainstorming for such a "low cost keyboard" is documented as early as July 1981—while the Keyboard Component was experiencing production problems. When Chang met with Glenn Hightower and staff from APh in December 1981, notes recounted that Mattel wanted "to redesign Keyboard Component to cut cost by at least 1/2 from $800 cost to $300" or create a replacement, "a low cost keyboard—just an extension to the Master Component."[6] While there has been speculation that the new keyboard was created to avoid potential legal action and fines from the Federal Trade Commision (FTC) related to the delayed Keyboard Component, this is incorrect. The FTC's involvement might have accelerated work on the new keyboard, but it was already in development and motivated primarily by price. When the FTC reached out to Mattel Electronics in summer 1982 the head of Mattel's legal department, Timothy Reames, hired an outside firm to help prepare a response. When the firm asked Reames in a letter, "Why did we switch to a scaled-down model?" Chandler's copy contains a handwritten comment on the margin: "Cost."[7]

Moskovitz was put in charge of the BDS in July 1982, renaming it the Entertainment Computer System (ECS). Reflecting its core mission, it was

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also nicknamed LUCKI (Low User Cost Keyboard Interface), often spelled "Lucky." One programmer suggested that Chang saw an opportunity to undermine Chandler with the low-cost keyboard. But Chang's group was just doing its job, devising a cheaper, toylike product that could make Mattel Electronics money while responding to management's concerns about the struggling Keyboard Component. As Hightower explained, the toy business "was in Chang's blood," and his "approach was always to mercilessly look for ways to cut costs without compromising quality." While some speculated that the ECS project was hidden from Chandler, Moskovitz insisted that "there was no secret group that Dave [Chandler] didn't know about. It's just that he had what he was working on."[8] Yet what Moskovitz termed Mattel Electronics' "dysfunctional organizational culture" was so fraught that an external review in late 1981 found "a lack of lateral communications," which "was identified by many as a serious inefficiency caused by duplication of efforts."[9] Moskovitz recalled "tremendous animosity between the groups and jealousy. Chandler had many strong feelings about having a separate engineering group that he wasn't responsible for." Others saw things differently. Vice President of Marketing Bill Gillis noted that Chang and Chandler "had similar end products they were pushing, though the path to get there was different. I didn't see them as headbutting competitors."

The manuals for the Keyboard Component and the ECS reveal similarities by emphasizing ease of use, foregrounding play and experimentation, and supporting the BASIC programming language.[10] Yet they were built on distinct visions. The Keyboard Component embraced self-improvement and neglected videogames to turn Intellivision into a home computer—as Chandler stated, "entertainment" was "dead ended" as a product goal.[11] In contrast, the ECS focused on games, and Moskovitz explained that "we were trying to turn Intellivision into a computing system that provided entertainment." Indeed, when meeting with APh in late 1981, Chang identified a "new keyboard emphasis" that would embrace "fun and games" with "all new software oriented toward games."[12]

While the events at McCormack Ranch were an apogee for the ECS team, they were a nadir for Chandler, who was there when the ECS debuted with fanfare. Paul Chandler recalled his father's anger at the ECS "because it just cut off what he had gone to Mattel to accomplish." In handwritten reflections, Chandler complained that "we are creating great confusion in the marketplace . . . Lucky builds a negative image of what a game based computer system is."[13] Chandler concluded that the intelligent vision that had inspired the Keyboard Component had been lost, writing, "There is no vision as to where we are going."[14] In fact, there was a vision stemming from Chang's Design and Development group and the history of Mattel toys, a

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vision of computing as creativity, fun, and discovery, as domestic entertainment intimately connected to games.

A Device for Discovery

The ECS's main menu listed three options: BASIC (to write programs), CARTRIDGE (to play videogames), and MUSIC. The first option focused on computing—discovering and using the built-in BASIC programming language. Reflected in the name "Entertainment Computer System," the core extension of the ECS was called the Computer Adaptor. Its input ports connected to a keyboard, with which the Computer Adaptor was paired as the Computer Module. Highlighting Mattel Electronics' embrace of modular extensibility, the ECS was a system developed to accommodate expansions. Consumers could purchase add-ons like a synthesizer keyboard or two additional hand controllers (for games with up to four players). They could also use another port for a printer or for a cassette player to save programs. The Computer Adaptor had a 12KD ROM chip with a custom EXEC operating system.[15] The Computer Adaptor also contained 2KB of system RAM and a sound chip that doubled Intellivision's sound channels from three to six. A Program Expander adding additional memory would have plugged into the top of the Computer Adaptor via a removable panel. Never used, this expansion port was glued shut in later models—a silent witness to the vision of modular extensibility.

Visual Designer Ted Mayer, who designed Intellivision II (chapter 8), was also tasked with designing the ECS. Mayer's Intellivision II aesthetic was inspired by stereos of the early 1980s, extending the analogy between Intellivision and stereos often used by marketers to explain the modular system. The initial idea was to mimic vertically stacked stereos by placing ECS extensions underneath Intellivision II, all on a cradle with a carrying handle like those on boomboxes (figure 10.1). For various reasons that included difficulties in engineering vertical connections between cartridge slots, Mayer settled on a horizontal configuration (figure 0.2).

After Scottsdale there was a push to get the ECS into production, with a press release announcing that "the original Keyboard Component has now been designed as a home computer with retail pricing anticipated to be under $150."[16] A trade magazine noted that the extension would enable Intellivision "to compete on equal footing against Atari, Commodore and TI models," and another claimed the ECS would allow Intellivision to "perform the functions of a sophisticated home computer."[17] Such ideas reflected the marketplace confusion Chandler anticipated, since the ECS would not be a sophisticated home computer like the Keyboard Component. One ECS

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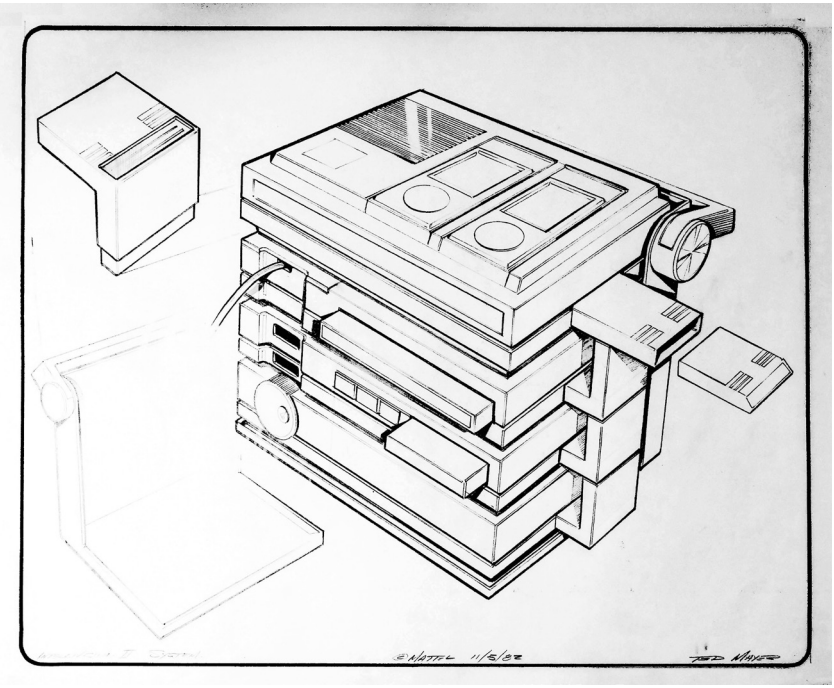

10.1 Ted Mayer's vertical design for the ECS.

brochure explained, "Intellivision is not a complex computer, it's an easy to operate system that lets you have fun while learning." Such language, ubiquitous in the industry and used for the Keyboard Component as well, aimed to assuage consumer fears about computers and their association with complexity and productivity.

The ECS was revealed at the January 1983 Consumer Electronics Show (CES), with press releases declaring, "Intellivision becomes a fully programmable computer" (figure 10.2).[18] By this time Radofin, which at one point had been a key manufacturer of Intellivisions, was still making consoles for the international market. Radofin also developed an inexpensive home computer that Mattel Electronics acquired and rebranded as Aquarius. Aquarius was also revealed at the January 1983 CES. While it had significant limitations and was not competitive with other low-cost computers, Aquarius demarcated a standalone home computer product line, helping underscore how the ECS was something different. For instance, the 1983 Mattel Electronics catalog described the ECS as an "entertaining new way to experience the world of computers." It was not envisioned as a true home computer but a tool to discover computing.

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10.2 The ECS as released (image from the 1983 Mattel Electronics Canada catalog).

A precedent to the ECS was the "Children's Discovery System" (CDS), released by Mattel Toys in 1981 (around the time the ECS was conceived). The CDS used cartridges and had 2KB of RAM, a simple keyboard, and a tiny LCD screen with a 16×48 resolution. The CDS was developed by Mattel but outside Mattel Electronics. Robert Knetzger, a designer leading CDS development, suggested that the original idea likely involved Richard Chang and came from the Preliminary Design group (chapter 1).[19] Knetzger was moved from Preliminary Design into Visual Design and consulted with Gordon L. Berry, a UCLA professor of education. Knetzger worked mostly with independent programmers outside Mattel to code the games. The CDS was designed for young children as an educational toy that, as one advertisement stated, could introduce children to "the world of computers," using the same phrase later employed for the ECS. In fact, the CDS was advertised as offering a version of BASIC, called KIDBASIC, to teach programming. Mattel Electronics programmer and manager Don Daglow even sent this advertisement to Moskovitz asking if this was "the 'feel'" that Moskovitz wanted for ECS educational software.[20]

While developed by Mattel Electronics, not Mattel Toys, the ECS was partially marketed as a learning tool for children, with games like *The*

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Jetsons' Ways with Words (to teach spelling and vocabulary). The emphasis on teaching BASIC reflected this. As mentioned before, the ECS was originally conceived as featuring a BASIC programming language for beginners. The Computer Adaptor carried the simplified ECS BASIC onboard. Programmed by Javad Hashtroudian, it deviated from standard BASIC. It lacked functionality, due in part to the haste with which it had originally been coded. It color-coded different elements of the programming language—like BASIC keywords, constants, and variables—to facilitate learning. It even changed traditional BASIC commands like "PRINT" to "PRIN," a point that worried some who thought it would teach the "wrong BASIC instructions to children."[21]

As problems emerged with ECS BASIC, the Systems Design Engineer Thom Randolph recalled being "tasked with determining whether the huge pile of assembly language that supposedly constituted a BASIC interpreter could even be tested, much less made to work"—it "ran into the hundreds of pages" with "no comments throughout the code."[22] Even Hashtroudian called the interpreter "exceptionally slow."[23] The programmer Keith Robinson complained that "a routine to add the numbers from 1 to 100 takes over eight seconds"; as a result, he supported the programmer Mark Urbaniec's snarky suggestion to "refer to it as a Baby BASIC or Basic BASIC, suitable only for teaching beginning concepts in programming."[24]

A Toy to Make Toys

The ECS's manual explained it would turn Intellivision "into a Family Entertainment Computer System" described as "a whole new world of fun, music, learning and computer power." The ECS articulated a vision for playful engagement with computing and videogames that drew on Mattel's history with electronic toys. As mentioned earlier, the ECS was to have a new focus on "fun and games," as Chang described it.[25] This dovetailed with later marketing research that noted the crowded field of low-cost computers—including the TI 99/4A, VIC-20, Atari 400/800—and concluded the ECS's competitive advantage lay in being the "best home computer for playing games."[26] The focus on games drew on Mattel's entertainment brand and Intellivision's strengths in graphics and sophisticated gameplay.

Marketing materials emphasized that the ECS would support "Super Games" with augmented gameplay, graphics, and increased user creativity, in particular the ability to manipulate the games themselves. Richard Hoag, Vice President of Sales, was quoted in January 1983 saying that "Mattel will be putting an emphasis on 'user modification,'" and the ECS was central

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to this vision.[27] One press release for the ECS promised it would bring "a whole new dimension to video games by allowing the player to change many aspects of the game such as graphics, skill level and game action."[28]

The ECS extended existing horizons of play, making Intellivision more interactive, modifiable, and visible as a computational domain. For example, ECS BASIC contained novelties like the special commands SHOW and GRAB (nicknamed the "sucky" commands) that allowed users to suck or "pull moving objects from a cartridge and use them on screen with his or her own BASIC program."[29] Fully seventeen pages at the end of the ECS BASIC manual (about 20 percent of the text) shows how to do this for a range of Intellivision cartridges—from the dragon in *Advanced Dungeons & Dragons* to the rocks in *Astrosmash* or the robot in *Night Stalker*. Thus, ECS BASIC users could play around with moving objects, changing their color and motion, and even create rudimentary games. Users could also toy with sounds, background color, and hand controller input, thereby manipulating Intellivision's technical structures.

While ECS BASIC ushered in a early form of remix, all ECS titles allowed for some form of user modification and creativity. With cassette player and synthesizer add-ons, *Melody Blaster* players could record their own melodies and play them in the included rhythm game or challenge a friend to try them. In the strategy game *Mind Strike*, players could design levels or program the strategy of the computer players Gus and Max, competing against their reprogrammed creation or watching the modified computer opponents battle each other. In *World Series Major League Baseball*, players could change, save, and reload team lineups. In *Mr. BASIC Meets Bits 'n Bytes*, players could alter the mechanics of three simple games, change the color and speed of moving objects, or program the computer to play. *Scooby Doo's Maze Chase* had an edit mode that allowed players to modify existing mazes or create their own. In *The Jetsons' Ways with Words*, players could input their own words to use in its puzzles, saving them on a cassette for later use. Thus, an imperative for ECS titles was that they be "user-changeable through the keyboard" in order to "match the advertised image of the product."[30]

This focus on user modification required new games and software. As with Intellivoice, exclusive ECS cartridges were needed to drive sales of the hardware, instead of selling consoles to drive cartridge sales. As a result, in August 1982 Vice President of Applications Software Gabriel Baum shifted programmers "to the Lucky project at the expense of the Intellivision Master Component team."[31] At the time, programmer Dave Warhol called this group the "Lucky Pioneers," invoking the informal "Lucky" name for the ECS to hint at the unlucky challenge of "developing software for a machine that [did] not yet exist."[32]

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Programmers were often frustrated that they had to redesign their work in progress for the ECS—a change that would make them unplayable on Intellivision's Master Component alone, thus limiting their sales. A comment in Warhol's *Mind Strike* code exemplifies this frustration:

; NOW WAIT A SECOND. I AM A KEYBOARD GAME. THAT MEANS I MUST
; HAVE A KEYBOARD. I DONT CARE WHAT MY PROGRAMMER SAYS, THAT
; I MIGHT WORK JUST FINE ON A PLAIN INTELLIVISION. I HAVE DECIDED
; I WANT ONLY TO RUN ON A LUCKY. SO THERE.[33]

Such frustration with "marketing mechanics" (chapter 6) also appears in a memo from Michelle Mock, who was developing a *Dungeons & Dragons* title.[34] When Daglow requested that it become an ECS videogame, Mock responded that major revisions would be needed and she didn't like playing games with a keyboard, adding "as far as 'commitment' to Lucky, I heard that about the previous keyboard and it didn't work out."[35]

While the ECS could be frustrating from a programmer perspective, its computational affordances allowed for user creativity in a way that the Master Component in isolation did not. Foregrounding user creativity and tinkering with videogames drew on a longer history at Mattel Toys. Lou Silberman started working at Mattel in 1960 and by 1967 had become International Marketing Director. When asked about Mattel toys before Intellivision that foregrounded technology, Silberman immediately responded that "there was a toy called Vac-U-Form." Vac-U-Form was a toy to make toys from the early 1960s. It "used the industrial process known as vacuum forming to make plastic molds on a small scale."[36] Its instruction manual showed kids how to pour hot plastic over molds to make toys that could be assembled and painted. Mold kits for a boat and race car were included—but featured as well were kits for a picture frame and costume jewelry pin, recalling products Elliot Handler had designed before Mattel's founding.

With Vac-U-Form and successor toys (including Thingmaker), Mattel turned toy design and manufacturing into play—a play pattern that Mattel called "make and play." This is not the same kind of play as building toys like Legos or an Erector Set. Instead, play value emerges from tinkering with toy design, the creative process of inventing and making toys, the very process internal to Mattel. Preliminary Design—where Mattel toys were conceived and prototyped—was called the "Funny Farm" in a nod to wild thinking, but also because its engineers saw their work as fun. As we saw in chapter 6, this association of work with fun was pervasive in Mattel Electronics. Both Vac-U-Form and the ECS sought to capture and market this spirit.

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The ECS was to Mattel Electronics what Vac-U-Form was to Mattel Toys. The ECS turned the process of making videogames into a product, marketing the play value of design itself. Programmer David Stifel's unreleased "Game Factory" cartridge for the ECS allowed users to create their own games using Intellivision's affordances and their own graphics (chapter 5). It was the ultimate expression of the idea permeating all ECS cartridges. Through the ECS, consumers could play the process of game design. Indeed, Robinson expressed concern that the explanation of moving objects in the ECS owner's manual "is pretty explicit. If a memo stating the same things were circulated to the programmers, it would have a big red CONFIDENTIAL stamp on it."[37] Thus, the ECS brought computing into the home but foregrounded playful discovery and creative tinkering over domestic productivity.

Through its embrace of computing as play, the ECS testifies to the emergence of player control over videogaming. The ECS was even earlier than the Family BASIC Keyboard, released in 1984 for Nintendo's Famicom system, which also allowed for user modification of games. Today, level editors and adjustment features are widespread. User-generated mods, like player-made interfaces for *World of Warcraft* or level creation in games like *Geometry Dash*, *Little Big Planet*, and *Super Mario Marker*, are now popular. In 1983 this was not yet the case. User control and design of videogames was in the air with programs like *The Arcade Machine* (1982) and Bill Budge's *Pinball Construction Kit* (1982–1983), and the ECS embraced this ethos of videogame modification and tinkering. While programmers could do some of these things on the original Intellivision, like the level design feature in Rick Koenig's *Motocross* (though levels could not be saved), the ECS extended this vision. Building on their Intellivision experience, Mattel programmers like Koenig, Warhol, Daglow, and Connie Goldman worked on influential games in this vein after Mattel, including *Adventure Construction Set* (1984), *Racing Destruction Set* (1985), and *Earl Weaver Baseball* (1987). Ultimately, the ECS reveals how the history of toys, play, and creativity shaped a vision of future gaming.

Making Music

Alongside programming and gameplay, music was a primary function of the ECS. This feature is also linked to Mattel's history and Chang's role in the company. Mattel's early success was powered by musical toys. From toy guitars to a range of music-making toys and eventually the 1971 Optigan organ, music was central to Mattel's vision of play (chapter 1). After being hired into Mattel's Acoustics Laboratory in 1964, Chang worked on a range

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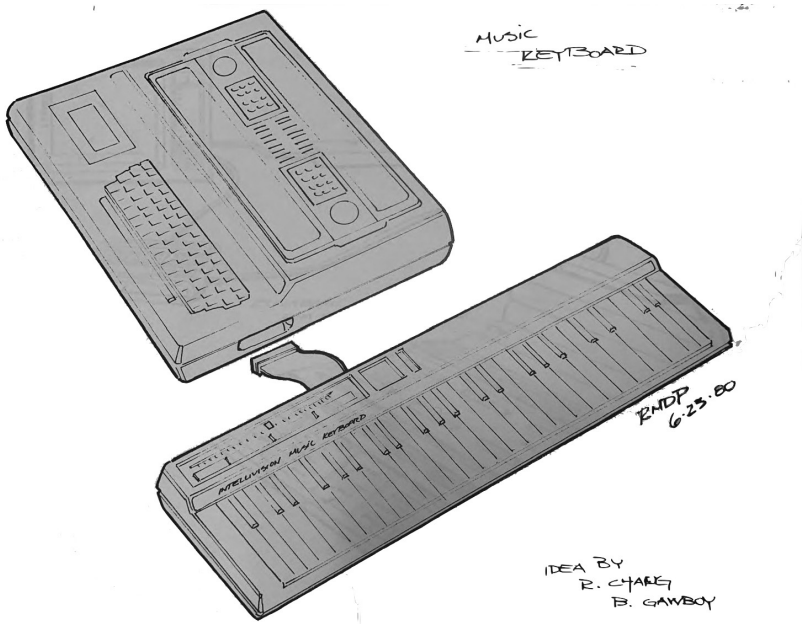

10.3 Music Keyboard proposal for the Keyboard Component (Richard Chang and Barton Gawboy, "Music Keyboard," June 23, 1980, National Videogame Museum archive).

of musical toys. He was not only Team Leader for the Optigan but credited on a key patent.[38] As Director of Design and Development, he oversaw musical instruments like the Synsonics Drums, sold under the Mattel Electronics banner. As Intellivision was being brought to market, Chang considered ways to incorporate music. For instance, in 1980, he proposed a forty-eight-key "Music Keyboard" that would plug into the Keyboard Component (figure 10.3). A range of unreleased music cassettes were also developed for the Keyboard Component, including a guitar learning cassette described as "a subject dear to the heart of Richard Chang."[39]

Like other consoles of the time, as a "video" game system, graphics were paramount to Intellivision. It is understandable that when turning to sound capabilities, Intellivision's programming manual "Your Friend, The EXEC" states in one sentence, "The sound chip makes noise."[40] However, despite this joke, Intellivision's AY-3-8914 Programmable Sound Generator (PSG) was a vital chip. It was designed by engineers at General Instrument (GI). Versions were used in multiple home videogame systems and arcade games and are still used by chiptune musicians and hobbyists.

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The PSG contains three voice channels. Programmers can "produce the basic square wave tone frequencies for each channel" by setting the period (or time of a single oscillation) to adjust the frequency, thus manipulating the sound to create various pitches.[41] They can also adjust the volume, generate noise (i.e., random static), or add an envelope to manipulate sound parameters like attack and decay (rising or falling volume).[42] The EXEC operating system provides additional routines for music generation and sound effects, largely written by Hal Finney at APh and integrated into the EXEC by David Rolfe. The EXEC's macros and routines for sound generation, called SCODE, helped programmers access and manipulate the sound chip while adding functionality like looping, randomizing frequencies, pausing, and other sound parameters.[43]

Programmers could also use an "N macro" to produce notes, stringing them together to compose. For example, the *NFL Football* code contains an introductory 6 note "charge" tune when teams take the field:

```
CHARGE::BEGIN
    CALL    ORGAN
    N       C,3,2,1
    N       F,3,2,1
    N       A,3,2,1
    N       C,4,4,1
    N       A,3,2,1
    N       C,4,8,1
    DECLE   0           ;POP OUT OF ORGAN SOUND
    MOV     #8,R0       ;CALL CROWD SOUND FOR 8 LOOPS
    CALL    CROWD
```

The N macro is defined with the parameters "Note, Octave, Length, End."[44] Programmers can specify notes like C, CS (C-sharp), CF (C-flat), set the octave and length of the note, and then set a bit for the "end" that produces a break between notes or slurs them together. The music code also allows programmers to select among organ, flute, or piano. These function as instrumental presets with the EXEC setting PSG registers for different effects. The notes played with the music code use all three channels for richer sound: for example, the organ and piano presets store harmonics at different octaves to play in the different channels for a single note.

The EXEC also contains a "small library of sounds," such as a buzzer, whistle, key click, and "roar of the crowd."[45] Early Intellivision cartridges used this library extensively. *Major League Baseball* and *NBA Basketball*

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simply begin with the EXEC's crowd sound, a lengthy bit of code despite its simplicity. The crowd sound—which Finney designed while listening to sounds from the football movie *Heaven Can Wait*—begins with two channels playing noise that grows louder, then uses a whistle sound in one channel with noise in another, and finally a buzzer using two channels. The crowd noise is procedurally generated and randomized, meaning players hear slightly different whistle and buzzer effects each time. For example, the code will produce a whistle or not, randomize its pitch, and waver the pitch up to three times.

Intellivision cartridges used sound for interface feedback, such as the key click heard in numerous titles. Sound effects could also augment realism, such as a dribbling basketball or shuffling cards. Other videogames integrated sound with gameplay. This could be to create suspense—as in *Shark! Shark!*, where an ominous sound plays when a giant shark appears or turns abruptly. It could be to provide information—as in *Advanced Dungeons & Dragons*, where rooms are revealed incrementally as the player explores a cave system. Some monsters are audible before they are visible. The manual suggests, "Move slowly in the caves and LISTEN. Many beasts can be heard as you approach." Here, sound not only informs the player of a nearby monster but sometimes identifies the kind of monster (for instance, flapping wings for a bat).

Actual music was rare in Intellivision games. Most were eerily silent, a noticeable gap within the domestic space of play where music could be heard better than in arcades, and gameplay lasted longer.[46] Moreover, the fact that "composers had to be programmers often meant that the music—typically just theme songs—was created by programmers with little or no training in music."[47] Early Intellivision music was limited to either short introductions, like the simple opening to *The Electric Company Math Fun*, or brief musical sequences, like the ten notes from Rossini's "William Tell Overture" that play after winning in *ABPA Backgammon*. Some later cartridges borrowed music more extensively. With 16KD (four times the space of original cartridges), Connie Goldman and Warhol's *Thunder Castle*'s music excerpts included Beethoven, Dvořák, and Schubert. Warhol explained that even with more space, achieving this feat required streamlining the music code: "It took like five decles to turn on a note and another five to turn them off. So I wrote a music driver that would only be one decle per note, and I was able to get five to ten times the amount of music than had been done before."

Intellivision programmers also created original music. Warhol wrote the tune that begins *Mind Strike*. Andy Sells composed a pulsing soundtrack for *Maze-A-Tron*, using "glitchy" noise generator effects to dovetail with

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the title's maze composed of circuits, buswires, and computer chips. Russ Lieblich, a trailblazer in videogame music who had a master's in music composition, composed the music for *Snafu* (a snake genre game), which was remarkable because it contained a continuous soundtrack of slithering snake noises, followed by a sudden death musical score when two players remained—a sonic indication of change that contributed to building tension.

As with other aspects of videogame design, the EXEC acted to facilitate but also constrain. For instance, the EXEC prevented the simultaneous use of music and sound because only "one sound processor (music or SCODE) may be running at any given time."[48] Moreover, rather than allow control over individual channels, the EXEC's music processor used all three channels for richer sound output. Thus, playing sounds using SCODE required halting any music. In titles like *Maze-A-Tron* and *Thunder Castle*, continuous background music is interrupted by sound effects triggered by player actions.

The ECS was designed to respond to these limits of the Master Component's music and sound. It included expanded RAM and an extra PSG sound chip, doubling Intellivision's sound channels to six. This extended musical possibilities, including the use of an add-on synthesizer keyboard and the ability to program sound. For *Scooby Doo's Maze Chase*, Warhol recreated a theme from Bach's "Toccata and Fugue in D Minor." Mark Kennedy, the title's programmer, noted that during the famed opening of Bach's piece, Warhol used the two sound chips to create an echo: "One was just running a fraction of a second behind the other one. So it really gave an organ sound." In addition, during the slow-building dissonant chord, Kennedy added that Warhol "was able to use the six channels and rotate them, so as a new channel came in, an old one dropped off. It sounds really good."

Selecting MUSIC on the main menu allowed the ECS to do three things. First, if the regular keyboard was plugged in, it would produce musical notes instead of letters. Second, users could switch out the regular keyboard for the Music Synthesizer. This forty-eight-key musical keyboard was nearly identical to the musical keyboard Chang had sketched in 1980 for the Keyboard Component. Third, specially programmed music cartridges could be used. Only one title was released before the crash—*Melody Blaster*, a musical version of *Astrosmash* where players shoot down notes falling from above by pressing the appropriate key at the right time on the synthesizer.[49]

One programmer developing music cartridges was Lewis Lazarus, who had a BFA in music composition from CalArts. Lazarus programmed the unreleased "Melody Maker," which he explained "would record, playback, and display musical notation," and eventually include the ability to load songs from a cassette. Lazarus emphasized that "piano players took a dim

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view of the program," but kids would "enjoy being able to play on it and hear back what they had done." Echoing the Optigan, such programs were half toy, half instrument. Indeed, the ECS manual included a section "Playing with Sound," which described the ECS's sound routines and how users could play with ECS BASIC to set tones as well as volume parameters like attack and decay. Thus, the ECS oriented Intellivision toward a platform future of playful user modification and entertainment.

Legacies of the ECS

The ECS certainly had limitations. It was a watered-down Keyboard Component with less memory and a poorly functioning, truncated version of BASIC. Its cheap plastic construction and ability to mess around with graphics from game cartridges suggest the ECS was a toy of sorts. The ECS manual emphasizes, "Overall, the only problem you may have with the kids and the computer is prying the two apart." Most know the feeling of childhood disappointment when a toy fails expectations fueled by marketing fanfare. James Pujals, designer of the homebrew Intellivision videogame *Christmas Carol vs. The Ghost of Christmas Presents*, wrote "I hate the ECS," explaining "I owned one when I was 11 years old . . . I fell for the dream of programming my own Intellivision games in BASIC, and letting my imagination fly. I was so excited and starry-eyed . . . but the device brought nothing but pain and frustration."[50]

However, the ECS deserves a place in the history of videogaming beyond its shortcomings or the fact that it was released only weeks before Mattel Electronics' end. The ECS reveals internal debates and practical solutions regarding the future of videogames at a pivotal historical juncture. This manifest in forward-looking games like *World Series Major League Baseball* (which employed the multiple camera angles of televised sports), *Melody Blaster* (which presaged rhythm games like *Guitar Hero*), and *Mr. Basic Meets Bits 'n Bytes* (which taught game programming). The ECS was more than a kneejerk response to the Keyboard Component's struggles and demise. Like the Keyboard Component, the ECS reflected the idea that Intellivision could become more than a videogame system—but from a perspective rooted in Chang's Design and Development group and the toy culture of Mattel. This perspective understood home computing as influenced by games and fun, not hijacking the Master Component's computing power for self-improvement and productivity. Thus, the ECS focused on extending Intellivision's capabilities in the direction of entertainment, improved "super" gameplay, and informal education. It gestured toward the pleasure of modifying games—adjusting parameters,

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playing with design, and tasting the delights of user-generated content. In doing so, the ECS asserted a "direct connection between playing and making games," turning game design itself into a source of play value and pioneering what we now call modding.[51]

Today we live in a world where user modification is ubiquitous, but during the second generation this was not the case. What would have happened had Mattel Electronics leadership hewed to its history making toys, such that the ECS—not the Keyboard Component—was the original vision for Intellivision's computer add-on? What if a schism between Chang and Chandler's groups had not existed, so that Chang could have asserted more control over Intellivision's platform future? What if an extension like the ECS had been released much earlier, not one month before Mattel Electronics folded? How would thousands of US consumers have reacted to an extension that allowed creative access to modify and remix videogames? We will never know, but the relative success of extensions like Nintendo's Family BASIC Keyboard suggests paths not taken. Indeed, the ECS allows us to imagine an alternative platform future and better historicize our own contemporary, user-generated world.

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PlayCable

11

"It's worse at night. That's when the spaceships come. As soon as I turn off the lights and close my eyes, they zoom out of nowhere."[1] The journalist Howard Polskin opened with these words when covering "PlayCable" for *TV Guide* magazine. PlayCable was an extension that plugged into the Master Component like Intellivoice or the ECS. It allowed Intellivision owners to download videogames from their local cable provider and play them at home, without using a cartridge. Polskin, who wrote the article about Intellivision programmers that began this book, explained that PlayCable "will pipe dozens of different video games into American homes and ultimately might acclimate Americans to using personal computers."[2] When *TV Guide* introduced Intellivision and PlayCable to the public, it was within a broad vision of an emerging, networked society. Images of spaceships and aliens might have kept Polskin up at night, but these were emissaries of a deeper social anxiety caused by unfamiliar information signals and strange new videogames invading the home.

In the early 1980s the networked society was arriving, and PlayCable was one of its early ambassadors. "Ready, Set, PlayCable!" reads one page from a folder of promotional materials.[3] The folder's cover announces "Your share of 3 billion dollars is right here," in black text on a red background that grabs your attention and warns that a profitable opportunity might be missed. The materials explain "how to get your share of the video game boom immediately" with another page showing a graph projecting that 50 percent of homes will have videogame systems by 1986. The background

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is bright green and peppered with images of Intellivision's iconic "running man" figure. The message is clear: green means go.

Unlike Polskin's *TV Guide* article, no consumer read these materials, which were to convince cable companies it was time to get in on the videogame action. An experiment responding to broader developments in consumer electronics, PlayCable was a modular extension of Intellivision, but one that was commercially unsuccessful. Yet, despite being largely forgotten, it announced the future. In the contemporary period, downloading games is near-universal: the days of cartridges, cassettes, and discs have passed. But in the late 1970s and early 1980s the landscape was utterly different, and it was revolutionary that these promotional materials would proclaim that PlayCable "downloads the game data."[4] PlayCable made Intellivision "the first system to have downloadable games via cable television," illuminating an alternative platform future for home videogame systems.[5]

Cable TV for Videogames

PlayCable arose in the context of the flourishing cable television industry. As it developed in the 1950s and 1960s, cable television was primarily intended to retransmit broadcasts for communities outside the urban centers where early television stations were based, "on what was called 'the fringe' . . . just at the edge of the receivable signal."[6] By the 1970s, expansion into urban and suburban markets shaped the emergence of thematic channels like HBO (1972) and Showtime (1976), which brought movies into the home. Experiments were taking place on the East Coast, where Jerrold Electronics was the dominant supplier of the set-top boxes connecting consumer televisions to cable. In 1967 Jerrold was acquired by General Instrument (GI), the company that would later develop Intellivision's chipset.

The engineer Charles L. Dages joined Jerrold from General Electric, and in the late 1970s helped develop DataChannel, a technology that could "generate a number of broadcast channels which were conceptually similar to FM radio stations" but delivered digital data.[7] In the late 1970s one-way and two-way interactive videotext systems were appearing globally, and there was debate regarding which was best for particular uses. One-way systems were cheaper and easier to implement but could only deliver data. Two-way systems were pricier and more complex but allowed consumers to transmit data back to a central database, useful for activities like home banking. Dages thought cable companies could use DataChannel as a one-way system. "The idea," Dages noted, "was that there would be a package of digital services that could be distributed." Ultimately Jerrold was "not a content company," but given GI's work with Mattel, he thought, "Why not

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take the library of cassettes that Mattel and GI folks are putting together, make an adapter to plug into cable, and download a bunch of Intellivision programs?" They pitched the idea to GI, and PlayCable was born as an "initial product" to "test market" the DataChannel idea and technology.[8]

Early experiments with using cable for transmitting game data date to the late 1960s.[9] With the rise of microprocessors, entrepreneurs like Ralph Baer and Nolan Bushnell had speculated since at least 1977 that "cable could also be used for microprocessor-controlled games."[10] It was in this context that along with Dages, Lew Solomon (Senior Vice President of Marketing at GI) helped conceptualize the idea of using DataChannel with Intellivision. Solomon recalled, "You had a great puzzle, but you didn't have a way to execute. When the proper technology and silicon came along, you now had all the ingredients." In one technical publication, Dages concluded that given "the average consumer has neither the desire [n]or the need to access large information data banks at the present time, the PlayCable system is designed to offer, initially, entertainment offerings, and then eventually move to information service."[11] Arguing against the consumer's current need for a two-way system, Dages picked videogames because they were ready at hand as an experimental stepping stone to a platform future of cable beyond television shows and movies—into worlds of data, network connectivity, and interaction.

As head of Mattel Electronics at the time, Ed Krakauer recalled that leadership thought it was "an exciting business opportunity" and "went through a long period of negotiating." GI and Mattel signed a letter of intent to collaborate in June 1978.[12] That October, Colin O'Brien, Vice President of Sales and Marketing at Jerrold, claimed the "first CATV-game interface" using a "Mattel game" would be released in December 1978 or January 1979.[13] These launch dates were not achieved, but it is remarkable that PlayCable was being hyped over a year before Intellivision was test marketed.

An organizational structure emerged alongside the technology. "The PlayCable Company" was incorporated as a joint venture between GI and Mattel Electronics. GI was the managing partner, and Gary Stein, a thirty-year-old protégé of GI's CEO, was chosen to head the new company.[14] "It was really Gary that turned PlayCable into a business," said Solomon. In December 1979, Stein hired Jim Wiesenberg from Showtime as Director of Marketing. With only Stein, Wiesenberg, and an administrative assistant, beginning in April 1980 PlayCable launched into nine-month test markets in five geographically separated cities: Jackson, Mississippi; Moline, Illinois; Rochester, Michigan; Boise, Idaho; and Brampton, Ontario (outside Toronto).[15] These cities had relatively new cable systems that were not only designed for improved television reception. They also provided

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"entertainment media"—a term used at the time for an "additional monthly movie package" like HBO—meaning their customers were familiar with new uses of cable and "might be likely to buy the PlayCable games package."[16]

Eventually The PlayCable Company moved from GI's headquarters and expanded to around thirty employees. Wiesenberg organized the marketing team, and Paul Hilt was hired as Vice President of Sales to organize the sales team. PlayCable officially launched on November 16, 1981.[17] However, GI's enthusiasm for PlayCable was not shared by its corporate partner. Gary Moskovitz, Director of Marketing, handled PlayCable on the Mattel Electronics side, but he said there was "not a push at all" from Mattel to expand it. As we shall see, Mattel had reasons to doubt PlayCable's positive impact on Intellivision.[18] While technically a joint venture, PlayCable was three thousand miles from Mattel Electronics and operated in near independence. Indeed, one of PlayCable's greatest challenges was navigating two corporate cultures, what Stein called "hip L.A. Mattel" versus "industrial, dirty-fingernail General Instrument."

At the Head End

Like the Keyboard Component, Intellivoice, or the ECS, the PlayCable extension plugged into the Master Component at home—but unlike these, it also had to communicate with a "Headend Computer" located at the cable operator. This Headend Computer stored the videogame data, which was then transmitted over the cable network to the PlayCable extension. Then users could play the games. A prototype of the Headend Computer, nicknamed "R2-D2" by Jerrold engineers due to its squat shape and wheeled base, was first publicly demonstrated in New York on May 15, 1979.[19] Dages recalled that the event was for analysts and journalists from the cable and financial industries: "We held the press conference in the faculty dining room uptown in Columbia and rolled [the Headend Computer] on the streets of New York from the parking lot to the school. Lots of looks from passersby."[20] The event was hosted by Solomon from GI, and no Mattel executives were present.

The "Jerrold Headend Computer" was a modified PDP-11, custom built for each cable operator for $11,900. Operators also paid a monthly fee based on both their total PlayCable subscribers and the monthly fee charged to each subscriber, which was between $8.00 and $12.00. (For instance, an operator charging 3,000 subscribers $10.00/month paid $13,800/month.[21]) In return, each month The PlayCable Company sent the operator a magnetic tape (a DECtape II Minicartridge). This would be inserted into the Headend Computer, which transferred the data into three or four communication

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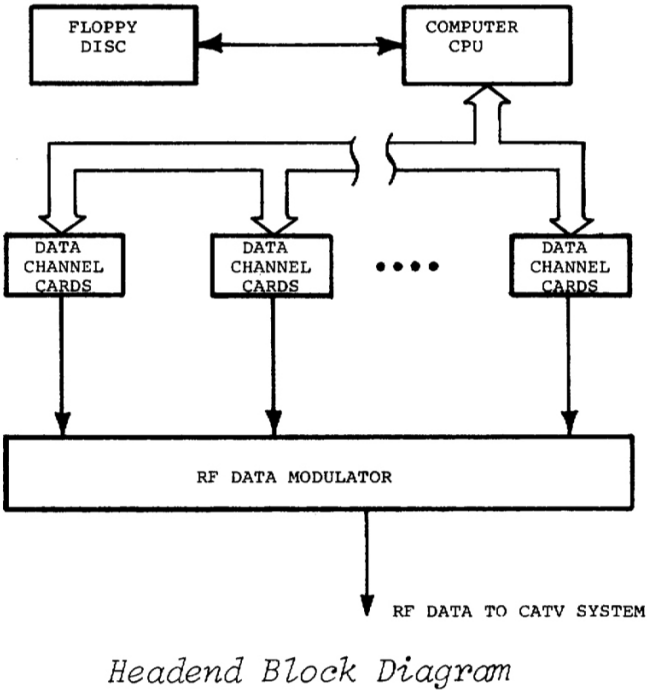

11.1 Headend Computer diagram (Charles Dages, "PlayCable: A Technological Alternative for Information Services," *IEEE Transactions on Consumer Electronics* CE-26, no. 3 [August 1980], 484).

interface cards, each "a complete two-channel serial data transmitter with its own local microprocessor intelligence."[22] These interface cards were, in effect, "small single board computer[s] based on an MC6808 processor."[23] They would reformat videogame data for transmission via cable over the FM spectrum and send it to the adapter (figure 11.1).[24]

The Headend Computer used eight FM channels to transmit videogames. One was dedicated to the directory of games available for download and had a fixed frequency of 107.7 MHz. The others contained two or three videogames each and could be located anywhere between 88 and 108 MHz.[25] The Headend Computer thereby made "economical use of the available spectrum by transmitting several game files on one FM channel in time sequence."[26] In other words, single videogames were not assigned specific frequencies along the lines of *Space Hawk* at 105.3 MHz, *Major League Baseball* at 98.4 MHz, and so on. Instead, the FM channels broadcast data in a looping pattern, with one, two, or three games appearing in sequence,

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each identified by a header of data. When a user at home selected a game from a menu on the television screen, their PlayCable extension would tune to the channel with the game and wait for the header data to come around in the data transmission. This led to different seek times, depending on what videogame was selected and at what point the processing began to seek the data.[27] Sometimes a user might get lucky and the system would tune to a channel right when that particular game data was appearing on the broadcast. At other times, consumers would have to wait a few seconds before the videogame appeared in the sequence of data.

Dages explained that Jerrold had worked out faster ways to download game data by using "block loads, a whole plan for how to feed the data to give the consumer a perception it was working instantaneously." He recalled marketers saying that "popular games will need to have faster response times." Splitting the videogame data would reduce seek times since they would come up more quickly on the channel broadcast to be downloaded. Dages's team had conceptualized how to chop single videogames into different-sized blocks to begin downloads sooner and even allow playing a game while the remaining data downloaded in the background. This innovative idea, widespread today, was ultimately not used. Intellivision games were not designed to be broken up in this way. However, the APh programmer David Rolfe's copy of the code for his game *Las Vegas Poker & Blackjack* includes a handwritten note "split at request of PlayCable." Rolfe explained that because *Las Vegas Poker & Blackjack* included two videogames on a single cartridge, "the 'split' is a reference to splitting the paired games into individual games."[28] This likely was requested to increase the number of available videogames, though splitting would have made downloading these games faster as well. While the split did not happen, even in the late 1970s Jerrold and GI were attuned to ideas that shape contemporary online user experience, including increasing available content, reducing download times, the perception of instantaneous loads, and privileging transmission speed for some content.

Jerrold's approach was pivotal to making PlayCable attractive to cable companies because it meant PlayCable did not take up a cable channel. As was recognized at the time, "most cable systems still have only 12 channels or less and are inclined to take the services that will attract the largest audience."[29] Fortunately, the Headend Computer transmitted data using "a combination of frequency and time division multiplexing which allows the use of any FM channels in the 88 to 108 MHz FM band that are available in the host cable system."[30] When speaking with hesitant cable operators, Hilt reminded them "you're adding an optional service without losing a [cable] channel. You could have 12 channels or 24 channels, but adding PlayCable

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is not asking you for the 13th or the 25th channel." One marketing brochure noted the data channels could be "sandwiched along the band wherever there is room between FM stations," which meant "you enjoy the luxury of unchanged video channel capacity."[31]

PlayCable's approach had yet another advantage. Cable channels retained the broadcast principle of weekly scheduling. To see *The Godfather* on HBO you had to watch it, say, on Sunday at 7:00 p.m. But with PlayCable you could enjoy *Major League Baseball* at 7:00 p.m., 7:12 p.m., or 10:44 a.m. As one commercial put it, PlayCable gave you "20 games to pick from 24 hours a day. No schedules to follow." PlayCable arguably represented the first on-demand videogaming service. Staff anticipated that this novel idea might confuse consumers, and one brochure answered a hypothetical question asking if consumers could only play games at scheduled times.[32]

Since no data returned to the Headend Computer, PlayCable was marketed as "'interactive' entertainment for one-way systems."[33] This benefited operators since no cable equipment upgrade was needed. As one marketing brochure proclaimed, "PlayCable is a one-way system that 'plays' like a two-way for your subscriber."[34] This phrasing reflects the debate over one-way versus two-way systems noted earlier. With the emergence of two-way systems, cable operators knew it was technologically possible for users to send as well as receive data. Instead of upgrading cable systems to become bidirectional, Jerrold's leadership argued that "a different kind of service is needed, one that gets the consumer involved with electronic data in his home and starts him on the learning curve."[35] Thus, PlayCable was sold as a pathway to two-way systems, and the name "PlayCable" was likely chosen in part for this reason.

The promise to cable companies was not only that consumers could play games delivered by cable, but that users could "play" cable. By "simulating two-way interaction over a one-way cable system," PlayCable prepared cable companies and consumers for the interactive communication systems of the future.[36] Thus, PlayCable acted as an early form of "gamification," broadly conceived as using games to accomplish tasks beyond simply playing them. Polskin quoted Stein asserting that, "With PlayCable, we have an entryway to moving a computer into the home under the guise of a video game . . . We're getting subscribers used to the idea of accessing information."[37] Four months before Polskin published his article, Hilt was quoted saying that a PlayCable player might not realize "while he's having fun with video games, he is also accessing information over cable from a remote terminal with a main computer at the head end."[38] PlayCable staff thereby envisioned PlayCable as helping subscribers in "'migrating' from an attitude of thinking of TV as a passive form of entertainment to something that

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is interactive," which could lead "toward using television to bank, shop, and do your income taxes."[39] Polskin articulated a similar view, concluding that pushing buttons during gameplay would "be a small step to punching more buttons to formulate a personal budget or to using the computer to determine the food I need to buy for the next four weeks."[40]

However, PlayCable's unidirectionality meant it was impossible to tell which videogames were being downloaded more than others. Two sources of information helped determine which titles to include each month. First, Dages explained that Mattel would provide data regarding which cartridges were selling best at retail, "so we knew which ones would be the red-hot games." Second, the back of the program guide had a feedback form subscribers could return when paying their bill. PlayCable staff used both sources of information to inform scheduling decisions—for instance, releasing some sports titles like *NBA Basketball* and *NHL Hockey* seasonally but offering *Major League Baseball* and *NFL Football* continuously. Wiesenberg came up with the idea of rotating the available videogames. This was important, Hilt said, because "we had to try to keep it fresh and we only had so much bandwidth that they could use to download games." PlayCable enabled a monthly programming schedule, reshaping the social practices of home videogame play and foreshadowing the contemporary economy of instant online access.

The initial goal was to gain two hundred subscribers in each test market, but this could only happen if cable operators purchased Headend Computers and agreed to the monthly fees. Hilt explained that PlayCable's "target audience were cable operators," not Intellivision owners. Their slogan was "The All Game Channel" because PlayCable was marketed first and foremost to cable operators as a channel, not to consumers as an extension. The early cable industry was fragmented, often with multiple operators in one city, and Stein emphasized that "there was a franchising war to show how avant-garde you were to the community." In this environment, PlayCable gave cable operators a way to stand out in the crowd, and hopefully add a revenue stream as well.

When marketing to cable companies, PlayCable staff did not tout Intellivision's superiority to Atari. Instead, they compared PlayCable with arcades. One brochure emphasized that "Americans will drop over 20 billion quarters into coin-operated electronic arcade games this year. This amount dwarfs the entire film industry's box office sales . . . financial analysts see the home market as the new area for skyrocketing growth."[41] PlayCable was sold in terms that cable companies could understand. Just as channels like HBO snatched revenue from movie theaters, PlayCable could siphon money from arcades.

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Contrasting PlayCable with arcades foregrounded benefits of the home environment. Brochures for operators asserted that "PlayCable is a family affair" and "video game playing is fast becoming the nation's #1 stay-at-home sport," while marketers emphasized, "The whole point to this is the kids stay home. The family plays together."[42] Media coverage concurred that "for subscribers with children who are video-game fanatics, PlayCable may be the lesser of two evils. Rather than spending their lunch money to play video games at the local pizza shop or game arcade, at least they'll save their money and spend more time at home."[43] The PlayCable Company also created template brochures and newspaper advertisements. These mirrored the marketing of Intellivision, honing in on themes of realism and intelligence by claiming that PlayCable is "amazingly realistic" or "the smartest way to enjoy Intellivision."[44]

While The PlayCable Company's customers were cable operators, the company also helped entice consumers to join PlayCable. In particular, they coordinated thirteen major advertising campaigns involving as many as twelve cable operators.[45] Three of these campaigns involved playathons, and many local operators organized local playathons in response.[46] Playathons typically took place in shopping malls, with multiple Intellivisions set up for tournaments, usually with prizes. One event, held over a three-day period in November 1981 in Poughkeepsie, New York, promised a "tournament of games" with hosts covering the action.[47] Photographs from another, four-day playathon, held in February 1982 in Fort Lee (outside New York City), show contestants standing before a long row of Intellivisions connected to TV sets at eye level.[48] Stein was among the PlayCable staff present as "competitors tried to run up record scores on *Astrosmash* and *Skiing*."[49] Like the "Intellivision VideoChallenge Tournaments" and "*Astrosmash* Shoot-Off" discussed in chapter 8, playathons were an early example of esports. Notably, playathons did not involve PlayCable technology itself but used cartridges to demonstrate the exciting possibilities for which PlayCable offered easy access. Thus, playathons and PlayCable helped educate consumers about Intellivision as a sophisticated, future-oriented system.

Playing PlayCable

While Polskin's *TV Guide* article discussed the promise of PlayCable, he admitted that "because the cable system I subscribe to doesn't yet offer PlayCable, the company also lent me the Intellivision cartridges."[50] As with the playathons, Polskin used regular cartridges, but nonetheless recalled excitement at what this new online technology might portend. Both Polskin's experience and the playathons reflect how PlayCable as a one-way

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service did not provide revolutionary play experiences like online competition but replicated the experience of regular Intellivision gameplay without cartridges.

For consumers, PlayCable appeared as the adapter extension, which plugged into the Master Component's cartridge slot. It contained a cable receiver that accepted the incoming data stream, "filter[ed] the appropriate channel out of it," and passed it through a demodulator that extracted the digital signal.[51] This was sent to the Application Specific Integrated Circuit (ASIC), the heart of the extension. The ASIC would send the digital information to the Master Component and also read or write data to the adapter's internal DRAM (dynamic RAM) storage based on requests from the Master Component.[52] Once the game data was downloaded and stored in the adapter's DRAM, the Master Component could use it to play the game.

Using PlayCable at home involved receiving a monthly "Program Kit" in the mail, containing instruction manuals, overlays, and a program guide.[53] Via cable, the Adapter would download each month's directory. The ASIC contains a small PlayCable EXEC ROM that takes over when the Master Component is powered on or reset. This program's "primary function is to initialize the PlayCable to a predefined channel, display the PlayCable title screen, then search, load and run a program named 'DIR1 CATALOG.'"[54] To the accompaniment of a ragtime song, the "start" screen would then show a list of available games.[55] Only one game could be downloaded at a time. It took about ten seconds to retrieve and store a 4KD game, and the adapter could load games up to 8KD, thus excluding 12KD cartridges like *Pinball* and *Vectron*.[56] Intellivision's colored bars on the title screen turned white, accompanied by a "ding," as each 1KD of videogame data was downloaded.[57]

Actual gameplay was no different than with a cartridge. However, forms of "paraplay"—experiences that occur outside or around actual play activity—shifted with PlayCable.[58] For instance, many Intellivision games had no restart command short of resetting the console. Replaying such videogames via PlayCable would require redownloading the title. Such a delay created different play patterns. "Once you started playing a game, you were stuck with it," recalled one PlayCable user.[59] This indicates that players might be deterred by reset times and either keep playing a particular videogame when they otherwise might have chosen to start over—or, if resetting, choose another title. There were also issues related to curation and player disappointment (or excitement) regarding monthly changes in the videogame library—recalling contemporary reactions to library changes on streaming services like Netflix or Amazon Prime. Thus, while PlayCable subscribers were videogame players, they also experienced new forms of agency mediated by the emergence of online entertainment.

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Despite its unprecedented innovation and Stein's 1980 prediction of ten million subscribers by 1984, PlayCable was "plagued by equipment problems and slow-moving sales."[60] Only about twenty cable operators ever participated, and only about five thousand customers ever subscribed.[61] "We never really made money," Wiesenberg said. While publicly estimating that cable operators were subscribing 3–5 percent of their customers, Wiesenberg added that the five thousand figure translated to a participation rate closer to 1 percent, at a time when participation rates for channels like HBO and Showtime were in the 20–50 percent range.[62]

The "biggest barrier" was "the price tag on the Intellivision unit."[63] A June 1982 marketing study still found that "those aware of PlayCable did not understand that they would need to buy an Intellivision."[64] Hilt recalled cable operators frequently asking, "'Can you use an Atari? Because there's a lot more Ataris out there than Intellivisions.' And I'd go 'no.'" Mattel Electronics executives wanted PlayCable to drive console sales, and so they rejected pleas to include a Master Component with the adapter as a rental package. "Mattel wanted us to sell the Intellivision unit," Wiesenberg said, and consumers "could buy it from the cable system, they could buy it from the store, it didn't matter, but they did have to buy it."[65]

Another issue was the limited selection of available games. It does not appear that the adapter's 8KD limit was a major barrier to including titles, since most Intellivision games remained under that limit. However, videogames were excluded from PlayCable beyond technological reasons. Anticipating contemporary dynamics where, say, Disney will not allow a show created for its platform to stream on Netflix, Mattel barred videogames by Activision and other third-party developers. Nor could PlayCable offer some licensed videogames, including the *Tron* games: "Those hopes were dashed when officially informed by Mattel, Disney titles were out," Hilt said.[66]

Why would Mattel Electronics block these possibilities for profit? PlayCable was a joint venture between Mattel Electronics and GI, but the relationship was unequal. Wiesenberg summed it up as "we were the darling of GI, but the bastard child of Mattel." Conflict between Mattel and GI compromised The PlayCable Company's work. "Our business was on hold an awful lot because the two companies were feuding," said Wiesenberg, "and so Gary Stein and I would go into the office and play a whole World Series [of *Major League Baseball*] in one day." For GI, PlayCable represented a novel use of existing technology and a revenue stream. But for Mattel, PlayCable was potentially an existential threat. Intellivision's razor/razor blades model was predicated on cartridge sales. Yet as early as 1980 Jeff Rochlis, the first

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President of Mattel Electronics, stated in print that PlayCable was "roughly half the cost of buying all the new cartridges every year," a huge discount that theoretically would leave a lot of product on the shelf.[67] As time passed, Mattel executives became increasingly "concerned about pirating the sales of cartridges," Moskovitz explained.[68]

This issue was particularly salient in terms of conflict arising between new and old games. Josh Denham, the second President of Mattel Electronics, noted that "broadcasting the old games was a great idea that had a lot of potential," but PlayCable staff kept "complaining because we weren't giving them the new games. And I said, 'Hey, we can't give you the new games because they've got to go to retail. If we give you guys the new games the retail is dead.' And so we ended up with a huge disagreement." From the PlayCable perspective, they were fighting an uphill battle because, as Hilt said, Mattel Electronics corporate perceived another business "potentially cannibalizing" sales.[69]

This perception was not unfounded: cannibalizing cartridge sales was central to PlayCable's strategy. Reflecting PlayCable's independence from Mattel, Wiesenberg and Stein used the advertising agency Lansdowne (not Ogilvy & Mather) to make four television commercials. Repeating Intellivision's emphasis on sports videogames, the commercials featured the legendary baseball player Mickey Mantle. These commercials emphasized that PlayCable could substitute for purchasing cartridges. For instance, in the commercial "PlayCable Arrives," Mantle states that "every month, you'll play an action-packed section of 15 Intellivision games . . . all for less each month than you'd pay for a single game cartridge." This idea struck at the heart of the second generation's revenue model—cartridge sales. PlayCable's advertising to cable operators also reflected this antagonism. Some of these materials suggested that operators explicitly contrast PlayCable to purchasing cartridges. "You'll never have to buy another cartridge," one brochure suggested, "One month of PlayCable costs less than ½ the price of a single game cartridge."[70]

Facing marketplace challenges and hostility from Mattel, in one "last big effort," PlayCable offered consumers in Corning, New York free Master Components with a subscription.[71] Even with these innovations, PlayCable was "basically a 'dead man walking,'" as Hilt put it.[72] In November 1983, as it became clear PlayCable would not survive, Hilt agreed to stay on for six months to close it down.[73] GI and Jerrold had to keep the cable companies happy, and so Hilt negotiated ends to the PlayCable contracts. Local cable operators also did not want subscribers to feel mistreated, and so Mattel Electronics provided each PlayCable subscriber with around ten game

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11.2 Winding path cartoon from PlayCable promotional materials (Jack Davis, "Intellivision Comes to Cable TV" [Corning NewChannels], The PlayCable Company, 1983, Paul Hilt archive).

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cartridges. It was an ironic end. PlayCable gave away free cartridges after selling consumers on the idea of a cartridge-less world.

An HBO of Games

"Becoming the HBO of games was our goal," Wiesenberg said. PlayCable staff encountered the challenge of marketing a new way of thinking about videogames, and as "an experimental game service," gestured toward an alternative platform future when "people might play video games against opponents across town or across the nation."[74] As early as 1980, PlayCable was deemed an exploration in the emerging domain of "computer communication," acclimating users to the future possibilities of online interactivity through digital play.[75] Those involved saw it as something that "created the art of the possible," as Solomon put it, "Now you had a technology to explore what you didn't know existed." Indeed, PlayCable's bleeding-edge experimentation, covered by press like *TV Guide*, buttressed Intellivision's brand of intelligent television and technical sophistication.

Among other innovations, PlayCable introduced to videogames the distinction between client-side and server-side hardware. No longer was Intellivision solely located at home, on the client side. The Headend Computer, the "heart of the system," extended new possibilities still relevant to online gaming, downloading, and streaming.[76] Many of those involved in PlayCable went on to shape these futures. For instance, Charles Dages was involved in developing the Prodigy online service, and eventually became Chairman of The National Academy of Television Arts and Sciences.

PlayCable's conceptual scope was thus formidable, but it was limited in terms of use and reach. It started early in Intellivision's history but remained in a state of precarity until the end. One of the final attempts to promote PlayCable featured a cartoon by the *Mad Magazine* artist Jack Davis.[77] In it, smiling throngs grasp the edges of a winding path composed of Intellivision games (figure 11.2). The message of excitement is evident. Everyone wants to climb onto this path of possibility. Yet, like many cartoons from satirical venues like *Mad Magazine*, a darker subtext emerges. The path itself is moving, and the smiling people hang on for dear life. Glasses, shoes, even adults and children plummet into the void. The image encapsulates the anxious ambivalence of an exciting journey to a future world of interactive entertainment and networked life, while facing a winding road of spiraling uncertainty. Mattel, GI, Jerrold, and PlayCable materialized this future for a brief period, but people were just not ready for it. "Users were favorable," Wiesenberg concluded, "but there were just not a lot of users." An HBO of games would have to wait.

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Transplatform

12

In a television commercial from 1982, a group of teenagers play Atari in a living room while an announcer exclaims, "Now for your Atari 2600, M Network *Super Challenge Football* and *Super Challenge Baseball*, from Mattel Electronics. Videogames that are so realistic, it's hard to believe you're playing an Atari." Suddenly, the television floats across the living room, terrifying the teenagers as the announcer concludes, "M Network videogames. They'll have a surprising effect on your TV." The M Network games in the advertisement are conversions of Intellivision's hit sports titles to the Atari VCS. Audiences at the time likely remembered Mattel Electronics' commercials with George Plimpton comparing Intellivision's *Major League Baseball* and *NFL Football* to Atari's equivalents, but the M Network games closely resemble Intellivision's titles, with the same number of players, field design, and "running man" figures. For Mattel Electronics to achieve this fidelity and quality on the rival Atari seemed unreal—as if a television would levitate in awe. Intellivision's renown as a sophisticated console was elevating the aging Atari platform, literalized by an intelligent television coming to life.

In this commercial, known within Mattel Electronics as "Sports Levitation," Atari becomes haunted by the Other, possessed by M Network videogames.[1] The reanimated Atari, brought back from the dead, invokes the horror genre and both the excitement and unease of producing cartridges for a competitor's system. This is the final destination of the concept of extension—extending one's system into the system of the Other and violating the sacred space of a rival's territory. The floating, wobbling television, which

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12.1 M Network magazine advertisement (two pages).

also appeared in print advertisements (figure 12.1), becomes a metaphor for the resulting instability of platforms as they extend into each other.

M Network is just one example of what we term "transplatform" relationships. The power of a platform studies approach is that it enables exploring the multidimensional character of a platform—from hardware to code, from design to marketing. A danger of this approach can be the implication that platforms are self-contained. We develop a transplatform approach to highlight how Intellivision and other videogame platforms are not isolated silos. Rather, they emerge and evolve through complex relationships with each other.

For example, M Network illustrates the transplatform relationship now known as porting, "the process of translating game software from one platform to another."[2] In the early 1980s, "porting" had not yet been coined and this process was called "conversion."[3] It was no mean feat: "When computers were coded 'close to the hardware' in assembly language, the internal architectures of two competing platforms had a drastic impact on the visual results."[4] No wonder the television floats across the room in the M Network commercial. Like a religious convert, Atari is haunted by the spirit of Intellivision.

Intellivision's transplatform relationships took four distinct forms. These incarnations illuminate how platforms travel beyond their individual

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technical and social boundaries. The first transplatform relationship is rivalry. Here, a platform is haunted by a competitor, and in this regard, we examine how Atari and even ColecoVision shaped the Intellivision system. Second are third-party developers. In this case, a platform is haunted by an uninvited Other, and we examine the impact of Activision and Imagic. Third is the process of developing games for a rival, when console makers haunt the Other by converting their games to competitor platforms. Here we analyze M Network and Atarisoft. The fourth transplatform relationship concerns changing systems, a total conversion enabling a platform to play another platform's games. We explore Intellivision's System Changer extension as an example of incorporating the Other.

Battling Atari and ColecoVision

Intellivision's rivalry with Atari was so all-encompassing that it was covered by the *New York Times*, which exclaimed that the console war had "all the makings of a great video game."[5] Throughout this book we have seen how Mattel Electronics played this game. Leadership pursued hardware extensions—a key aspect of Intellivision's identity—to differentiate the system from Atari's cheaper VCS console.[6] Executives and marketers created the successful Plimpton commercials that asked consumers to compare Intellivision's and Atari's capabilities. Marketing research comparing Atari and Intellivision included studies of advertisements, purchasing habits, consumer awareness, play satisfaction, and price comparisons. Marketing, hardware development, game design, box art, cost reduction—comparison with Atari impacted them all. Indeed, the marketer Mike Doepke emphasized that "Atari was number one. When we were doing our research, it was all about, 'What's Atari up to?'"

Most rivalries are asymmetrical, and this was no exception. Intellivision was released two years behind Atari and remained a distant second.[7] As the Product Manager Kathy Austin Lockton emphasized, "No matter how hard we tried to gain market share, Atari was just so incredibly entrenched." Because Atari always retailed for about $100 less than Intellivision, one might say the rivalry began with cost engineering. The Industrial Engineer Linda Bruce, who methodically disassembled the Atari VCS for Mattel, noted that the goal was "to find out if they were doing anything cheaper or better or more efficiently than we were." This was cost engineering, not reverse engineering. Bruce explained, "My job was there because management wanted to know how to fight that hundred dollar gap."[8]

Mattel Electronics programmers also studied Atari's capabilities, with the programmer and manager Peter Oliphant recalling that "we thought

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of Atari as being the only competitor." They even clipped articles about Atari's technical features. One such article, from the associate editors of *IEEE Spectrum*, contained a section called "Comparing the Hardware" that investigated Intellivision and two other consoles in relation to the Atari VCS.[9] A document discussing Atari's technical construction contained a handwritten note, "See the March '83 issue of IEEE Spectrum," revealing how programmers read and shared such articles.[10] Mattel Electronics staff also held seminars about Atari. One seminar announcement asked, "Ever wonder what makes the competition tick?" promising "a brief look at the VCS system. What the Atari can do and what the highlights are of all the things it can't."[11] Such comparisons reveal that console rivalries shaped the emergence of platform studies, which was not simply an academic curiosity but a technical perspective integrated into the social lifeworlds of engineers and designers.

The rivalry with Atari also shaped Intellivision games. The original focus on strategic, realistic sports attacked a gap in Atari's catalog and emphasized Intellivision's sophistication. Moreover, early design elements focused on Intellivision's strengths. For example, at the time it was noted that "Intellivision's forte, according to industry observers, is games with detailed but static displays."[12] Since Intellivision's background grid of graphics cards made it easier to display more detailed background graphics than Atari, programmers created multiple "fields of play" in the same videogame, highlighting Intellivision's graphical flexibility (chapter 2). The programmer Russ Haft emphasized that "there was always the comparison to Atari. Intellivision had a lot more horsepower. People were proud of that and really pushed that." The programmer and manager Don Daglow put it simply, "We wanted to do things they couldn't do." For example, *Space Hawk* programmer William Fisher recalled foregrounding Intellivision's sixteen directions of movement over Atari's eight, allowing the hunter to rotate, move, and shoot in these directions.

Without a transplatform perspective, a substantial part of the significance of Intellivision game design would go unnoticed. For example, Intellivision's sixteen colors were one of its most obvious shortcomings, particularly when Atari could produce 128 colors.[13] Intellivision's sparse color palette was further restricted by limitations of the STIC graphics controller: for example, each moving object could be set to only one color at a time. Working within these constraints, Fisher designed *Space Hawk*'s "rainbow bubbles" to cycle through eight primary colors to produce a vibrant "tinkly effect." Fisher emphasized that this feature helped Intellivision compete with Atari's more robust color palette. Furthermore, Fisher programmed background graphics full of flickering stars and colorful bubbles

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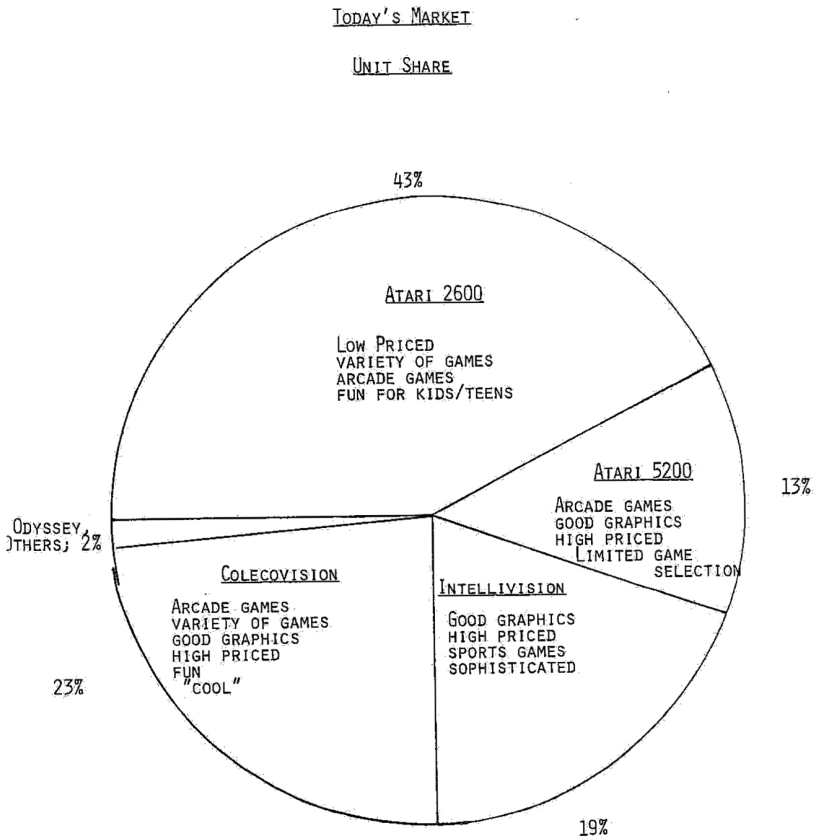

12.2 Internal marketing presentation slide showing market share analysis (Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, Cory Schwartz archive, 15).

to emphasize both color and Intellivision's superior, detailed backgrounds. Fisher explained that "the fundamental philosophy of what we were trying to do with every game was to make ourselves look better than Atari."

While Atari dominated Mattel Electronics' attention, a transplatform relationship emerged with ColecoVision as well (figure 12.2). Coleco was a toy company that ventured into consumer electronics and videogames even before Mattel, eventually becoming a primary competitor to Mattel Electronics in the handheld game market. In fact, a year before the Plimpton commercials, Coleco ran side-by-side television and print advertisements touting the superiority of their *Electronic Quarterback* handheld, shaping Intellivision's aggressive advertisements in the years ahead against Atari.[14] When Coleco entered the home videogame market in August 1982 with their

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"ColecoVision" system, it clearly referenced Intellivision. Its hand controllers were similar to Intellivision's, with a twelve-button keypad that could accommodate overlays. It also had extensions, including Expansion Module #1 (which allowed the system to play Atari games) and Expansion Module #3, which turned ColecoVision into a home computer (later released as the standalone Adam computer).

Coleco turned a dyadic rivalry into a more complex triadic rivalry. It upended Intellivision's rivalry with Atari because Intellivision could no longer claim to be the most advanced system. ColecoVision was technologically superior in many respects, including its thirty-two moving objects to Intellivision's eight and higher-resolution display capabilities. Moreover, Mattel Electronics could no longer lean on modular extensibility as a unique selling point for a home videogame console. As we discuss near the end of this chapter, Expansion Module #1 was deemed a particular menace.

Third-Party Developers

Beyond competition between platform developers, a second kind of transplatform relationship involved new companies who bypassed making consoles altogether. The crucial innovation of the second generation was the introduction of cartridges, which separated videogame software from hardware. Companies could now make games for existing consoles. Since they would be freed from hardware development, and cartridges cost around $4 to make, wholesaled for around $16, and retailed for around $30, there was an "alluring arithmetic" to this possibility.[15] Such companies were called "third-party" developers. They were uninvited guests, entering through the open door of a system's cartridge port. Third-party developers impacted transplatform relations throughout the industry—including the circulation of labor and technology—and galvanized the technical exploration of platforms.

The first third-party developers were Activision (founded in 1979 by former Atari staff) and Imagic (founded in 1981 by former Atari and Mattel Electronics staff). One motivation was dissatisfaction with growing bureaucracy and organizational politics. Jim Goldberger, one of the first Intellivision marketers, initially worked with top management such as Jeff Rochlis (first President of Mattel Electronics), but when Rochlis left, Goldberger began working for a new manager with no background in videogames. The programmer Brian Dougherty recalled Goldberger's dissatisfaction having gone "from doing all the marketing with Rochlis to being pushed two levels down in the organization." Thus, Goldberger left to cofound Imagic,

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encouraging Dougherty to join. Dougherty eventually left Mattel Electronics because he was reassigned to work for Richard Chang instead of David Chandler (the engineer leading Intellivision's hardware development). "That was the trigger for me," Dougherty said, "I probably never would've left to start Imagic if I had been continuing to report to Dave Chandler." Thus, the tensions between Chandler and Chang discussed throughout this book had important consequences. Having learned the ins and outs of Intellivision under Chandler, Dougherty brought this knowledge to Imagic, where he designed an emulator and wrote code similar to Intellivision's operating system to aid Imagic programmers.

Third-party developers also emerged because of growing dissatisfaction with the disjuncture between a second-generation revenue model and a first-generation labor model. During this period, the work of making a videogame was analogized to programming a mainframe computer. Programmers were paid on a salary or one-time fee basis, with no royalties or authorial credit.[16] For instance, APh would typically charge Mattel Electronics $25,000–$55,000 per game (some early titles were as low as $12,000).[17] The programmer would be paid as little as $3,000 if they were a part-time summer employee. After initial work by several other APh staff, Tom Loughry was given *Advanced Dungeons & Dragons*, for which he did the bulk of the final design, including reworking its mazes, designing the monsters, sounds and interactions, and creating the top-level world map the player navigates.[18] For approximately eight weeks of work, Loughry was paid less than $5,000. As of June 1983, 698,000 copies of this cartridge had sold to retailers. If we use $25 as a rough average of its retail price and counting unsold stock, this would translate to around $15,000,000 in sales. However, game programmers increasingly saw themselves as authors, analogous to novelists or musicians. As a result, third-party developers could poach skilled programmers from Mattel Electronics and Atari by offering royalties and authorial credit.[19]

Labor flows led to the circulation and exploration of technical knowledge, as when Dougherty left Mattel Electronics for Imagic. Because of these flows, third-party developers had to reverse engineer consoles (hiring engineers to figure out how they worked or paying an outside group for the information) to avoid or fight lawsuits. The purpose of carefully documented reverse engineering was, as Goldberger noted, "to show that we weren't taking any institutional knowledge with us and violating any of the patents. You can prove, 'Look, it's basically public knowledge.'"

A related issue arose when many programmers left APh (the company that coded many of the original Intellivision games) to form the third-party developer Cheshire Engineering, which distributed Intellivision games

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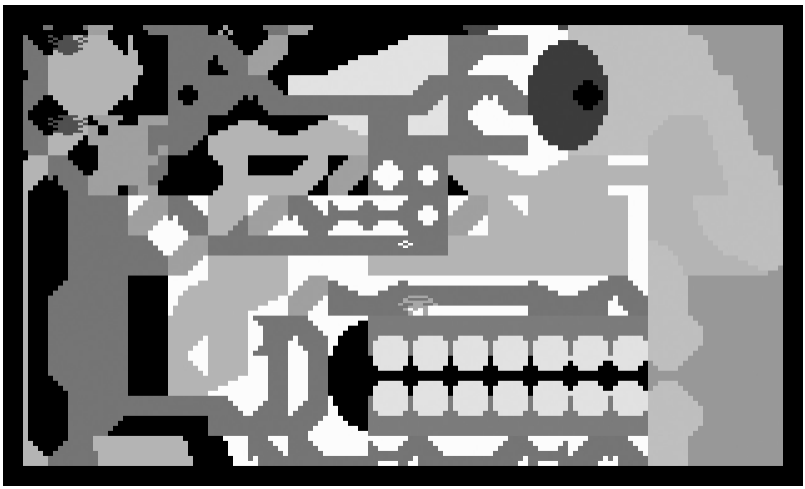
through Activision. David Rolfe, who had programmed Intellivision's EXEC operating system for Mattel while working at APh, could not even use his own code at Cheshire. Programmers had to bypass the EXEC since it was proprietary software owned by Mattel. This encouraged Cheshire programmers to create games that were more responsive and fluid without the bottlenecks created by the EXEC, titles like Rolfe's *Beamrider* and Loughry's *The Dreadnaught Factor* and *Worm Whomper*. *Worm Whomper*, for example, ran at 60 Hz, three times the speed of games using the EXEC. Thus, third-party developers helped catalyze further technical experimentation in game design.[20]

Third-party game design involved a mix of brainstorming and responding to competition. For instance, *Microsurgeon*, an innovative Intellivision game programmed by Rick Levine at Imagic, involves piloting a microscopic ship through a human body to fight illnesses (figure 12.3). Dougherty recalled how the concept "was loosely based on the movie *Fantastic Voyage* where they shrunk a ship and sent it into the body."[21] Levine had worked for a medical diagnostics company between leaving Mattel Electronics and being hired at Imagic, which inspired his work on *Microsurgeon*. Intellivision's background grid facilitated the creation of a detailed, scrolling representation of the human body, and through the repetition of background cards and compression techniques, Levine was able to create a large anatomical map to explore. One impetus for *Microsurgeon* was Mattel Electronics' catalog of sports and space videogames. Dougherty explained that "we felt like there's this huge canvas of games to be developed. And Mattel's not getting to all



12.3 *Microsurgeon* body map (close-up).

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of them," adding that this meant Imagic designers "were forced to be more creative; we were looking for new themes."[22]

Thus, third-party developers galvanized creativity and technical exploration. One of Activision's founders, Jim Levy, said at the time that "I think we electrified the industry. We came out of nowhere and took a generational step forward in terms of game design—I think even ahead of a lot of the Mattel work."[23] In fact, Levy claimed, "Mattel's Plimpton ads were just what we needed—it's that sort of competitive instinct that goads people to go beyond what's acceptable to what is unexpected."[24] The combative Plimpton commercials argued for the graphic sophistication of Intellivision games over Atari's offerings in the public courtroom of national television, implicitly prodding Atari programmers to up their game. Third-party developers were stimulated by such rivalry, expanding the competitive tenor of the industry.

In turn, quality videogames from third-party developers spurred creative work at Mattel Electronics. A January 1983 study proposal emphasized that "the marketplace for Intellivision-compatible software has become increasingly competitive. Activision, Parker-Brothers, Imagic, and Coleco will offer Intellivision games during 1983."[25] The proposal argued that Mattel Electronics games could no longer rely on their brand for sales but needed "good game play, game theme appeal, and game uniqueness."[26] New games had to be stellar to compete. The completed study recommended changing games in development to increase excitement and action.[27] Days after the study was released, Daglow wrote to programmers requesting "New Game Ideas," explaining that "the market has changed" and marketing "has specifically requested some original ideas."[28] During this period, programmers at Mattel Electronics increasingly pushed each other to explore advanced programming techniques like stealing interrupts, GRAM sequencing, and bypassing the EXEC operating system to design faster and more responsive games.[29] Third-party development had poked the Mattel Electronics hive.

Developing for the Rival

The Mattel Electronics commercial "Sports Levitation," which opened this chapter, depicted M Network enlivening an Atari and lifting a television to float around a room. The idea that M Network videogames would reanimate a lackadaisical Atari was a common marketing message and industry perception. One review of *Astroblast* (an M Network conversion of *Astrosmash*) proclaimed, "Mattel prides itself on raising the intellect of game systems . . . now with the M Network series, it could be said they're trying for *Smartari*."[30] A print advertisement for M Network emphasized similar themes, showing a scrambled message above an Atari console: "DDA EWN

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ELIF OT IRATA CSV TIWH M NETWORK MEHO DIVOE MEGAS." The puzzle addressed a "smart" consumer who could decode the slogan, "Add new life to Atari VCS with M Network home video games." The message was clear. M Network videogames would extend the viability of Atari's dying console, adding intelligent life to the system. Moreover, the cartridge slotted into the Atari, barely visible, is "Space Attack," the conversion of Intellivision's *Space Battle*. M Network videogames were attacking Atari's turf.

Hidden within this message was a reference only Mattel Electronics staff would appreciate. The scrambled word for Atari, "IRATA," was the original codename for "Project Irata," a "very closely held secret," said Gabriel Baum (Vice President of Applications Software).[31] Project Irata—"Atari" spelled backwards—was Mattel Electronics' internal designation for videogames created for the Atari VCS. Project Irata eventually became M Network. Mike Doepke, who became Director of Marketing for the project, noted that "M Network" hinted at Mattel without explicitly identifying it.

M Network exemplifies a third form of transplatform relationship that combines rivalry and third-party game development. If a third-party developer like Activision could make games for Atari, Mattel Electronics could do the same thing with its own Intellivision titles. Why not make cartridges for a rival's console? This became an important form of transplatform relationship that is rare in the contemporary period. We do not find Microsoft making games for Sony's PlayStation, or Sony making games for Microsoft's XBox. Instead, contemporary console manufacturers cultivate exclusives—titles available only for particular platforms or subscription services. However, in the nascent videogames industry, the costs and benefits of choosing to convert titles for other platforms or retain them as exclusive content was in flux.

Converting Intellivision titles to Atari had been discussed with Mattel Electronics' advertising partner Ogilvy & Mather. Gary Elliot, their Vice President for Software Advertising, was concerned that "the market was becoming overconsumed. The greater audience out there was the Atari game machine." Producing games for Atari's base made sense. According to Doepke, this approach was above all "a play to generate more revenue and to do it quickly because we already had the game concept on Intellivision." But the idea caused unease. At Mattel Electronics, Senior Vice President of Finance and Planning Paul Rioux noted that building great games for Atari could undermine Intellivision sales, and many staff members shared these concerns. "If you're trying to build your own brand," said Mattel Product Manager Al Nilsen, "You want *BurgerTime* on Atari? You're eating away at your own market."

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As described in chapter 8, APh developed the first M Network cartridges for Atari, converting many Intellivision titles including *Frog Bog*, *NASL Soccer*, and *NFL Football*. A few M Network titles (like *Star Strike*) kept the same name as the Intellivision originals, but most were changed (for instance, *Armor Battle* became *Armor Ambush*). Mattel Electronics programmers soon began development as well. Doepke worked with these programmers to choose promising titles to convert. "It was a joint collaboration to decide," Doepke said. "I would identify, 'These are the popular games on Intellivision.' Then the programmers would say, 'Well, this will switch easily over.'" Applications Software programmers developed several released M Network videogames including *Bump 'N' Jump*, *BurgerTime*, and *Kool-Aid Man*.[32]

The success of converting Intellivision titles to Atari led Mattel Electronics executives to pursue converting games for other platforms, including ColecoVision and even home computer systems like the Apple II and IBM PC.[33] These conversions appeared under the M Network label but were produced entirely within Mattel Electronics, without APh support. As Rioux emphasized, Mattel Electronics eventually "decided that we wanted to be, long term, a software company doing great software and enhance not only our own system, but other people's systems as well." The idea that other platforms were not rivals but systems to be enhanced reflects how transplatform relationships were, in effect, reframing competitor systems as extensions of the Intellivision brand itself.

BurgerTime exemplifies what Mattel Electronics marketers soon labeled its "multi-flavor" approach. This term played off the notion of line extension familiar to Mattel's marketers. Like bubblegum with many flavors, an Intellivision game could now have other platform "flavors." For example, materials prepared for a *BurgerTime* promotion with Wendy's franchises exclaimed, "It's an all-flavor title, with versions that can be played on Intellivision, Atari 2600, Apple II, IBM Personal Computer, Aquarius Home Computer System, and Mattel Electronics portable electronics game."[34] As an exclusive arcade game license from Data East, Intellivision *BurgerTime* might drive console sales—and in fact, *BurgerTime* was the cartridge included with Intellivision II. But *BurgerTime* was also a megahit arcade game, the most popular licensed title that Mattel Electronics had obtained, especially when compared to Atari's licenses like *Space Invaders* and *Pac-Man*. Thus, executives demanded that *BurgerTime* appear on every platform possible.[35]

BurgerTime embodies a transplatform object—hardware or software that must be understood in relation to multiple platforms. When the programmer Ron Surratt claimed that converting *BurgerTime* to Atari was impossible because it required many detailed moving objects—a chef and chasing

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enemies—marketing staff demanded it be done.[36] Despite initial misgivings, Surratt completed the conversion, but with additional cartridge ROM and RAM needed to create multiple levels and convert the complex gameplay.[37] Surrat also strove to minimize the flicker when drawing more moving objects than the Atari hardware can support—thus adhering to the directive to avoid flickering objects in Intellivision games (chapter 7).[38] M Network *BurgerTime*—like other arcade conversions such as *Pac-Man*, *Donkey Kong*, and *Space Invaders*—was more than a new version of a popular hit. It emerged from multiple social and technical relationships. It began as an arcade title, then gathered further significance from its licensing, its multi-flavor marketing, forms of Intellivision gameplay ranging from landscape orientation to minimized flicker, and the memory extensions added to haunt the Atari platform. Not all transplatform objects have these particular characteristics, but *BurgerTime* M Network reveals the intricacies that transplatform relationships can engender.

As M Network was taking off, Atari responded. By 1983 this took form as part of "Atarisoft," a brand name Atari used when converting its games to competitors' platforms. Early that year, the recruiter Shirley Dellavople from Advanced Technology Consultants contacted several Applications Software programmers. Haft remembered, "One day she called and said, 'It's a meeting at a hotel' and she said, 'Atari.' And so a group of us went there." The group—Haft, Eric Wels, and Mike Winans—were invited to found an Atarisoft office for Intellivision. Haft remembered that they were promised about a 20 percent pay increase from their Mattel Electronics jobs, as well as royalties from cartridge sales. Furthermore, space would be found near Mattel's offices, so they would not have to relocate to Atari's headquarters in Northern California.

The three left Mattel Electronics in early April 1983 for a brand-new building on Lincoln Boulevard south of Santa Monica—the area now known as Silicon Beach.[39] Haft was chosen to manage the new group, reporting to Richard Frick, who was based at Atari's headquarters. "There was a lot more autonomy," said Haft. "Everybody else was a programmer. It was just put your head down and write a lot of code." Even though Mattel was converting its videogames to Atari's platform, one month later Mattel sued for $40 million in punitive damages plus unspecified actual damages.[40] The suit included "an injunction to prevent Atari from using Mattel trade secrets" and was filed against Atari and individually against Haft, Wels, and Winans.[41]

A second wave of hiring brought in other employees from APh and Mattel Electronics, including Mark Kennedy, who began converting *Centipede* to Intellivision. Kennedy noted that Atari engineer Ed Logg, who helped design the arcade version of *Centipede* with Dona Bailey, was reverse engineering

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Intellivision at Atari's headquarters. To prevent claims that former Mattel Electronics staff were aiding Logg, they were allowed no direct communication. Haft said, "We'd get faxes. 'Here's some documents. Here's how the controller works.' We knew how to program, and we knew the instruction set, but all the details with the STIC were handy to have." Ironically, this communication ban meant that while Kennedy was working on the *Centipede* conversion, he could not speak with Logg, *Centipede*'s original coauthor. "If I had any question about the game," explained Kennedy, "I had to write it down and submit it to somebody else, who would submit it to him and then he would reply and submit it back." Because Kennedy knew Mattel Electronics would likely try to reverse engineer *Centipede* once it was released, "right at the very beginning of my code, I put in a message: 'Why are you disassembling this code? Don't you know that's not nice?'"

The original plan was to reverse engineer the Intellivision's EXEC operating system as well. However, Kennedy recalled discussing with Haft how "most of the development time for the people at Mattel was spent trying to work around the EXEC instead of with it." Kennedy emphasized that because the Master Component had been designed to work with the Keyboard Component and PlayCable, it "did two things before it started the EXEC. It looked at two other addresses to see if there was code there." Based on this knowledge, Haft and Winans preempted the EXEC by using one of these addresses, triggering what they called the Master Control Program (or MCP), named after the villain in the movie *Tron*. Unlike the EXEC, the MCP was included on each cartridge ROM, which were no longer limited to 4 KD.[42] The MCP "was just a library of code that you would make calls to," said Haft. Some aspects of the MCP improved on Intellivision's EXEC. Kennedy recalled the MCP updated Intellivision's hardware using "two-cycle counts of 30 Hz so the games would be peppier," faster than the EXEC's 20 Hz, and Haft noted the addition of a scroll module. The MCP converted the spirit of the EXEC, gathering generic code into its structures, while extending a familiar framework brought from Mattel Electronics. This illustrates a form of transplatform labor.

Converting videogames between platforms might seem the epitome of coding drudgery, but Atarisoft programmers found the process creative and liberating. As Haft emphasized, "You didn't have to think about all the issues that you do with a game in development," because the game already existed in another form. Haft added that "we had a room filled with 20 arcade games, no money needed. You could go in and play all your favorite games as many times as you needed, so that you knew you were getting the essence." This essence involved gameplay specifics—as illustrated by *Pac-Man*. "The algorithm in the *Pac-Man* game totally follows what's in the

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arcade," Haft explained, "which made it a lot nicer. Because every one of those little ghosts has a personality." Programmers used their experience playing arcade originals to determine the essence to convert—the spirit of the original moving from one platform to another, like a ghost. A transplatform approach provides a way to conceptualize how the spirit of a videogame transcends individual platforms. Instead of authentic original versus derivative conversion, videogames are conceptual assemblages with differing material embodiments. After all, it is likely that most who play *Pac-Man* in the contemporary period have never done so in its original form, but rather have encountered ghosts of the original. As games scholar James Newman has noted, accounting for how videogames have been "developed and released across multiple platforms" compels us to ask: "Which version of that game do we mean?"[43]

When Winans converted *Pac-Man* to Intellivision, the spirit of Intellivision's hardware appeared as the programmers scrambled to prepare for the 1983 Summer Consumer Electronics Show. Haft recalled Winans phoning around midnight to discuss a crazy bug: "At one point Pac-Man touches something and he fills the entire screen. We were just hysterical." Panicked, Haft and Winans started looking through the code together. On Intellivision, Pac-Man was a moving object controlled by the STIC. In addition to defining the number and color of moving objects, the STIC offers a variety of settings that change an object's appearance and behavior. Each of Intellivision's eight moving objects has an 11-bit word for horizontal position, a 12-bit word for vertical position, and a 14-bit word for "identification and control."[44] One function of the STIC is "zooming" an object. Bit 10 in the horizontal word controls the X zoom, which elongates a moving object and displays each pixel in its card twice. The graphics card, eight pixels wide, now appears sixteen pixels wide when displayed. While graphics cards can only be doubled in size horizontally, more options exist for manipulating their vertical display (table 12.1).

Bit 7 controls whether a moving object is constructed from one or two graphics cards—with the second card positioned below the first. The Pac-Man moving object was built from two cards. Bit 8 within the STIC's vertical

TABLE 12.1. 12-bit vertical position word.

Bit Numbers	**11**	**10**	**9**	**8**	**7**	**0–6**
Function	Y mirror	X mirror	Y zoom	Full size or half height resolution	1 or 2 graphics cards	Vertical, Y position

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word shrinks graphics cards used for a moving object to half their normal height while retaining their normal width. Thus, Pac-Man, composed of two cards, is shrunk to fit in a smaller space, though with finer resolution and detail. The STIC's vertical word also contains another zoom feature. Bit 9 "controls Y zoom" and works in conjunction with bit 8 "to provide a vertical selection of 1, 2, 4, or 8 drawn lines before a data change."[45] This means that the vertical height of each pixel can be drawn finely at one television scanline high, normal size at two scanlines high, or stretched to four or eight scanlines. For example, a single 8×8-pixel graphics card, normally sixteen scanlines high, can be quadrupled to sixty-four scanlines high.

Winans had mistakenly set a bit used by the STIC to adjust the Y zoom of the Pac-Man moving object. As Haft recalled, "We're looking through the code and sure enough at one point he's writing to the wrong address and it's the STIC chip. There's a bit that you could use to change the size of the sprites." Since the Pac-Man moving object used two cards, when the bit was changed, Pac-Man became 128 scanlines high, or two-thirds the height of Intellivision's screen! Here, one of Intellivision's platform affordances announced its ghostly presence, revealing how converting a videogame's essence struggled against the technical structures of platforms.

Changing Systems

The fourth kind of transplatform relation concerns its logical endpoint: incorporating the Other by manufacturing hardware extensions to play rival cartridges. For Intellivision, this endpoint took the form of the System Changer, an expansion module that could play Atari cartridges, released by Mattel Electronics in November 1983. This extension "changed" the Intellivision system by appropriating another system entirely and was borne out of an emerging environment "to market adapters which would allow software designed for another producers' hardware to be played on the company's system."[46]

Mattel was not the first to develop such an extension. Expansion Module #1, which could play Atari cartridges, was released simultaneously with the ColecoVision in August 1982. While developing ColecoVision, engineers realized they could reverse engineer Atari's custom TIA (Television Interface Adaptor) chip and build an Atari VCS with a TIA clone and other off-the-shelf components. Expansion Module #1 was simply an Atari in Coleco casing, bypassing ColecoVision's chipset entirely.[47]

As with ColecoVision's extension, Intellivision's System Changer was, in essence, an Atari VCS, bypassing the Master Component save for connections to the power supply, coaxial television link, and hand controllers.[48]

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However, in a very real sense Intellivision's System Changer did not clone Atari but ColecoVision's Expansion Module #1, revealing a complex set of transplatform relationships between three different systems.[49] Mattel Electronics' market research indicated that Expansion Module #1 "was ColecoVision's main competitive advantage."[50] Although it played Atari games, Intellivision's System Changer responded to the ColecoVision rivalry. In fact, early promotional materials named the forthcoming Intellivision extension "Expansion System A." This mimicry of "Expansion Module #1" reflected its true target, although Mattel Electronics soon began promoting its extension as the System Changer.[51]

Even though the Atari's 6507 CPU (a version of MOS Technology's 6502 chip) and 6532 RIOT chip (RAM-I/O-Timer) were documented and available, Mattel had to clone the custom TIA chip. The System Changer used a technology called Chip-On-Board (COB) that replaced an integrated circuit with a "bare chip" wiring that was then covered with "a glob of epoxy or plastic."[52] In addition to cutting manufacturing costs, the COB technology would obscure the TIA clone, making it difficult to see how it operated and potentially making it harder for Atari to sue Mattel.[53]

Through its technological mimicry, the System Changer allowed Mattel Electronics to challenge the claim that Atari had the largest library of games. Press releases highlighted that Intellivision could play around 375 videogames when the System Changer was added.[54] Market research confirmed the extension was an "important peripheral" that "addresses a major Intellivision deficiency" and "blunts ColecoVision."[55] Selling System Changers was not the only purpose of the extension: it was important to marketing Intellivision as well. Nilsen reflected, "You're looking for selling points for mom and dad," and being able to play Atari's videogame library while also being on par with ColecoVision was crucial. Market research showed that the System Changer increased "the perceived value of the Master Component," and for consumers who did not own any game system, it increased "intent to buy" an Intellivision by 38 percent.[56] Mattel Electronics even considered (but decided against) a transplatform conversion of customers: Atari owners could upgrade their console by purchasing an Intellivision and then trade in their old Atari for a System Changer.[57]

Nathan Altice referred to the System Changer and similar extensions as "parasitic platforms," since "the host console did not shoulder any of the emulation weight."[58] In biology, symbiotic relationships are parasitic if damaging to the host, commensalistic if neutral (like orchids growing on trees), and mutualistic if beneficial (like bees pollinating plants). How might we understand the System Changer as a commensalistic platform,

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or even a mutualistic platform? After all, the System Changer did not harm Intellivision and conferred clear benefits. A transplatform perspective clarifies how the relationship between platforms and extensions can be more than parasitic. The System Changer, Atarisoft, M Network, third-party videogame developers, and rivals are not strange curiosities on the periphery of true, essential platforms. Instead, they are part of the sociotechnical ecosystem within which platforms mutate, thrive, and change.

Transplatform Studies

Transplatform relations are one result of the logic of extension. Mattel Electronics embraced extension as a fundamental aspect of Intellivision's identity, and in many ways Intellivision can be understood as a transplatform, constituted through imbrication with other platforms. What is "Intellivision" once you can plug a cloned Atari console into it that was created in response to an extension from ColecoVision? It becomes a bizarre hybrid; for example, since the System Changer worked with Intellivision's idiosyncratic disc controllers (unless one purchased Atari controllers to plug into the unit), an unintended, even monstrous, play experience emerged from replacing Atari's joystick. The M Network advertisements described earlier allude to the destabilization resulting from transplatform objects like the System Changer and M Network, where the floating, shaking TV set is haunted by the possibilities of transplatform relations. This points toward a field of transplatform studies as a multi-perspective approach to videogame system analysis.

Transplatform studies helps illuminate the second generation of videogame systems in terms of hardware, software, and social relations. For instance, Intellivision and Atari can be seen as a single transplatform object with numerous points of intersection. With the System Changer, Intellivision becomes a transplatform object, gathering multiple platforms within itself. Or a videogame like *BurgerTime* becomes a transplatform object composed of multiple conversions. Beyond hardware and software, even staff can be understood as transplatform objects, translating concepts and practices as they converted videogames, moved between jobs, and founded third-party development companies.

Furthermore, transplatform studies can provide insight into dynamics of platforms to the present day. This includes enduring forms of rivalry. Most analyses of the "console wars" begin with the Nintendo/Sega rivalry of the mid-1980s.[59] The earlier Intellivision/Atari rivalry influenced that transplatform relationship, as well as later rivalries up to contemporary examples

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like the PlayStation/Xbox rivalry. Moreover, transplatform dynamics were never limited to videogame systems, and platform wars appear everywhere from the Macintosh/PC rivalry of the 1980s to Apple iOS/Google Android. Transplatform studies also has broad value for rethinking social platforms like Instagram, TikTok, YouTube, and Facebook, foregrounding how such platforms co-constitute each other in a systemic space of rivalry and integration.[60]

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Crash

13

"In Touch with Tomorrow" reads the cover of the 1983 Mattel Electronics dealer catalog. Inside, the company promised to offer "dazzling innovation" and "an array of exciting and advanced products. Products in touch with the magic of technology." The catalog contained images of hands and fingers touching buttons and controllers—suggesting that tomorrow was not only within reach but had arrived, graspable through Mattel Electronics' products. Yet the images of smiling faces and playing hands were surrounded by black voids. The home and accoutrements of everyday life featured in early Intellivision catalogs were gone. The new images of consumers in featureless darkness, absorbed in the captivating play value of digital entertainment, suggest a future of estrangement from physical reality. This was a tomorrowland far from Mattel's origins—selling toys to fill the home—and far from Intellivision's debut, when advertisements and brochures nestled wood-grained Master Components into living rooms with furniture, plants, decor, and a television. Intellivision's intelligent vision was alive but transforming, unstable, unsure.

While Mattel Electronics exclaimed it was in touch with tomorrow, it was increasingly out of touch with reality. Following a dismal 1982 Christmas season with unprecedented losses and the turmoil of unsold inventory retailers sought to return, Mattel Electronics experienced the beginnings of its demise. Despite its joyful faces, in hindsight the 1983 catalog seems to foreshadow an impending collapse that would engulf Intellivision and almost sink Mattel. The catalog's cover image featured a finger surrounded in darkness, about to press a button. This was likely meant to invoke "power

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on," implying that the products within would illuminate a bright digital future. In retrospect, the button could just as easily signify "power off" for Mattel Electronics.

Intellivision's story is forever overshadowed by "The Crash of 1983" (the "Crash"). Today, transitions between console generations are typically gradual, with older and newer consoles coexisting for years. However, between the second and third generation the Crash caused nearly every home videogame company in the United States to declare bankruptcy or leave the industry. For a period of about two years, it appeared that home videogame systems might disappear completely, until the rise of the Nintendo Entertainment System in 1985–1986.[1] A deplatforming of the domestic videogame space was seemingly at hand.

Early Warnings

While the crash metaphor accurately invokes collapse, this was not an instant catastrophe like a car crash. There were warning signs, and many within and outside Mattel Electronics read them. Marketers at Mattel were trained to read them because toys were particularly prone to boom-and-bust fads. Additionally, crashes were not unknown in the videogame industry, even in its infancy. An earlier crash occurred at the end of the first generation. Foreshadowing the Crash of 1983, observers concluded that "because of the large number of manufacturers in 1977, there were too many T.V. games produced which led to write downs and special close-out sales. This depressed the dedicated T.V. games market."[2] For instance, by the end of 1977 the AY-3-8500 "Pong-on-a-chip" developed by GI engineer Duncan Harrower (chapter 2) was being used in over 160 systems and "supply far exceeded demand. The market imploded, and during the course of a few months, the market for *Pong* consoles completely disappeared."[3]

Handheld games, so pivotal to Mattel Electronics' early success, also provided warnings. Sales for 1979 were estimated at $425 million, with Mattel leading the industry.[4] However, unit sales dropped from 2.6 million units in 1979 to 2.1 million in 1980; observers spoke of a glut in the market and competition with consoles.[5] Marty Miller, Director of Marketing Research for Mattel Toys, forecasted handheld sales and "saw that handhelds were gone. It's not going to make the numbers that the sales guys and everybody else was looking to get." However, corporate paid little attention. After the forecasts proved accurate, Mattel Chairman Art Spear placed Miller in charge of marketing research on Intellivision but kept him reporting to leadership in the more established division of Mattel Toys (not

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Mattel Electronics). "Art was so afraid that would happen again," Miller recalled, that "he wanted an independent source of viability testing."

Handhelds were toylike and familiar to Mattel, but Intellivision was different. The console was complex and costly, exacerbated by the push into home computing. Mattel's leadership was aware of the risk of diversifying business away from toys. They had been warned against this by their own corporate planning teams. As mentioned in chapter 3, in September 1980 Mike Welch, Director of Corporate Development, sounded an alarm soon after the Master Component's national release. Welch and his colleagues wrote a memorandum opposing entering the unpredictable computer business, emphasizing that it would require massive investments of time and money, the hiring of engineers and a new salesforce, and developing new distribution channels. Instead, they recommended focusing on electronics related to toys and entertainment. Anticipating the Crash with uncanny accuracy, they suggested Mattel "continue to market Intellivision until the programmable video game market becomes obsolete (predicted to be between F82 [Fall 1982] and F84)."[6]

The impact of such warnings faded as Mattel Electronics boomed. By 1982 Mattel Electronics had become Mattel's most lucrative division, centered on Intellivision. Programmers were hired so quickly that they did not have cubicles or clear tasks, even as the division finalized plans for a move to the posh "Continental Towers" building a couple miles from Mattel's main offices. Josh Denham, President of Mattel Electronics at the time, recalled how Mattel's "corporate group thought, 'God, we've struck gold here' and those of us that were closer to it didn't know what the hell was going to happen." Denham explained that with revenues approximately doubling every year during the boom, "we were on an expansion roll, which was really my fault." Denham likened the boom to the famed Monte Carlo Rally race, exhilarating but uncertain, driving at night "and you don't know when the next curve is."

Denham's decision to expand quickly despite this uncertainty reflected a broader assessment that home videogame systems would predominate into the foreseeable future, but only about 10 percent of these systems were Intellivisions.[7] Intellivision was losing the rivalry: "Atari's unit sales were more than seven times that of its closest competitor Mattel."[8] Expanding market share was a priority. In August 1982 Mattel Electronics announced a $50 rebate, reducing Intellivision's price to $239.[9] The rebate likely contributed to growing revenue. From August 1 to October 30, net sales of Mattel Electronics products were $223.5 million, a $135.8 million increase from the same period in 1981.[10] The rebate was accompanied by a bizarre television

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commercial with George Plimpton announcing the promotion while in a cage with lions—a sign that Intellivision's fierce competitive advertising, full of ideas, had become a sideshow and empty spectacle, foreshadowing that the curtain would soon fall. The sales boom did not last. By December 1982, Mattel Electronics warned it "will report a loss for the fourth quarter due to a weak retail environment and increased competition."[11] The year 1982 ended on an ominous note. Mattel lost $20.2 million that holiday season, a 22 percent decline that the company blamed on diminishing Intellivision sales.[12]

Marketing researchers at Mattel saw the end coming. Craig Spitzer, Marketing Research Manager, recalled that Mattel contracted with a company conducting a tracking study surveying around fifty thousand households every January, April, July, and October. Spitzer paid to add a few questions to their survey, including "how likely are you to buy a videogame console in the next 90 days?" Thus, Spitzer noted, "We had this nice stream of data." Cory Schwartz, who helped analyze the data under Spitzer, remembered how for the October 1982 survey "it was very high. It was going up, up, up." But the January 1983 results revealed plans to purchase a system dropping by almost half (figure 13.1). Spitzer recalled Schwartz entering his office to discuss the data and saying, "In the past three months it's going down. It's not just going down seasonally. Something is different about it. It looks like the world is losing interest in videogames." Spitzer felt uncertain because "the groupthink at the time was, 'Don't be stupid. Mattel Electronics is a billion-dollar division and we're the future. Soon people are going to stop buying Barbie dolls, but no one's going to ever stop buying videogames.'" But Schwartz insisted there was a problem. Spitzer recalled that "we probed in the data and we had one of these 'holy shit' moments—there's really something here. The market is getting tired of videogames."

They showed their findings to Miller, their boss, who asked them to meet with Denham, Bob Anderson (President and Chief Operating Officer of Mattel), and other top executives. After Spitzer's presentation, Anderson asked if he was certain: "I said, 'Trust me, I got this stuff down.' And Anderson looked at me with one of these 'I'm going to rip your head off' looks and said, 'Young man, I take this very seriously. I expect you to do the same.' And my career flashed in front of my eyes." Denham coldly said, "Thank you," and the marketers left the room. Outside, Spitzer recalled that Miller "basically slapped me in the back of the head" for being so glib with the executives. Spitzer was chastened at the time, but he and Schwartz had seen the writing on the wall. As Schwartz put it, "Everybody who was going to buy a videogame console had bought one, and it's over."

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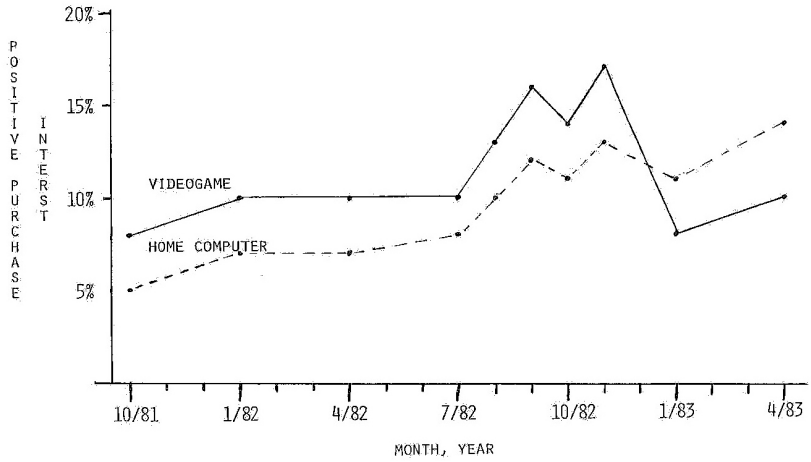

13.1 Mattel Electronics research regarding consumer interest in videogame consoles and home computers (Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, Cory Schwartz archive, 6).

These debates over warning signs underscore how "boom" and "crash" were not simply periodizations. They were also matters of affect and belief—intense feelings Denham analogized to a thrilling, dangerous car race. The 1982 Christmas season was a time out of joint when Intellivision was, in a sense, rising and falling at once. By the end of Mattel's fiscal year in January 1983, quantitative metrics clearly indicated a crash was underway.[13] Yet many at Mattel and beyond felt that videogames were still booming.

Overextension

The Mattel Electronics 1983 dealer catalog does not begin with Intellivision but with Aquarius, the low-cost home computer created by Radofin and rebranded by Mattel Electronics (chapter 10). The catalog celebrates Aquarius for nineteen pages, then turns to Synsonics electronic drums, handhelds, and M Network games. Intellivision does not appear until page 45—more than halfway through—a sign of its aging place in the market. Yet Intellivision's spirit permeates the catalog. The M Network videogames are Intellivision conversions for Atari; the handhelds are Intellivision titles like *BurgerTime*; every Aquarius game is an Intellivision conversion. When Intellivision finally appears, the catalog highlights the Entertainment Computer System (ECS), System Changer, and Music Synthesizer extensions.

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The language of expansion suffuses the marketing copy. When introducing the ECS the catalog exclaims "Expand your imagination," noting the "Intellivision Entertainment Computer System was created to be expanded."

In 1983 Mattel Electronics' vision of modular extensibility remained. Extensions and expandability were central to the Intellivision system from its beginning, with the Master Component envisioned as its heart. Even Intellivision's extensions were extendable: the Keyboard Component, ECS, and Intellivoice included expansion ports. From early on, Mattel Electronics leadership envisioned that videogames were the springboard to a digital future. Guided by this vision, it made sense to expand. Extending the system was the way to get into touch with tomorrow. In chapter 8, we analyzed the boom as giving birth to hyperextension, a formidable expansion where Mattel Electronics pursued multiple initiatives. Eventually hyperextension appeared as overextension, fueling excessive production and the duplication of efforts—taxing resources, draining profits, and confounding organizational structures. Mattel Electronics' finances increasingly were overextended in their own right, particularly when sales and revenue dropped. By 1983, when Aquarius, Intellivision II, and the ECS were coming to fruition, expansion was increasingly out of step with market realities.

For example, narratives of the Crash correctly emphasize the impact of a cartridge glut. The success of the boom years led to industry-wide overproduction, including at Mattel Electronics. Vice President of Marketing Research Alan Fine emphasized, "What killed Intellivision was not so much that they couldn't keep pace with demand for new games. The sales and management overestimated the marketing sales potential of it after a couple of years in the market." The resulting inventory backlog after the 1982 Christmas season added to the cartridge glut, and Mattel Electronics and other companies were forced to discount.[14] The explosion in third-party developers also contributed to cartridge overproduction. By the 1982 summer Consumer Electronics Show (CES), about fifteen such companies presented Intellivision games.[15] At the time Mike Doepke, Director of Marketing for M Network, referred to the environment as "survival of the fittest."[16]

However, overextension was not limited to cartridges. Initially, hardware extensions were intended to be profitable and increase market share by distinguishing Intellivision as an expandable system compared to the Atari VCS.[17] The Keyboard Component—the first extension besides PlayCable—set the stage for overextension. Its complexity, technical problems, and perpetual lateness meant it required enormous resources to develop. Engineers at Mattel Electronics were focused on lowering costs of the doomed component, while programmers at APh were creating operating software, development tools, and cassettes for the extension when they

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could have been developing more innovative games for the Master Component or focusing on an improved next-generation system.[18] One individual at APh explained that "the Keyboard Component kept us from improving the Master Component" and was one "reason Mattel [Electronics] did not survive the video game crash."

Other hardware extensions contributed to overextension. For Intellivoice and the ECS, Mattel Electronics executives decided that to stimulate hardware sales, cartridges created for both of these extensions would not play on the Master Component by itself. This backfired. Sales of Intellivoice were low and for the ECS—released later—even lower. Staff had to reskill and dedicate precious time to game development, but the titles created for Intellivoice and the ECS sold far less than if anyone with a Master Component could have played them. Other extensions like PlayCable and the System Changer represented another variant of overextension. PlayCable's ability to download videogames threatened to undermine sales of regular Intellivision cartridges—as did the System Changer's ability to play Atari games.

Overextension means extending too far, and Mattel Electronics extended far from Mattel's roots and from Intellivision's Master Component itself. Intellivision was originally envisioned as a programmable videogame system, expanding Mattel's presence in the traditional toy category of "games" through electronics. However, the desire to extend beyond toys and games into everything from computing to teletext and home banking diverted attention and resources away from videogames, straining the heart of Mattel Electronics' business. Miller, who had a rare seat at the table with top executives, explained that they lost sight of Intellivision. "They were making money hand over fist, and then they went to a separate building and wanted to do all sorts of things," Miller recalled, "They wanted to go into the computer business. They took their eye off of Intellivision to broaden their base and [pursue] all these crazy things."

In the early period of the US videogame industry, analogies mattered. Were videogames toys, consumer electronics, or a springboard to home computers? Mattel's handheld electronic games were self-contained—a mixture of toys and portable calculators. Intellivision was a system, framed in terms of stereos and other home electronics of the time, thus stretching the analogy beyond toys. This led to the establishment of "Mattel Electronics" as an independent division from Mattel Toys, and CES—not Toy Fair—as the core industry event. Miller explained that leadership saw Intellivision as "just the first piece" and began to think that electronics "were going to be the wave of the future and that toys were the old thing." Thus, the analogical shift from toys to electronics was at the heart of overextension.

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Intellivision was a videogame platform but quickly became a concept, brand, and extendable idea that could be stretched. Throughout Intellivision's product life, a tension existed between Intellivision as a game system, extended from toys, and Intellivision as a system that could put consumers in touch with tomorrow—be that through downloadable games, home computing, or even home banking. Eventually, as Mattel Electronics expanded toward the future, this double vision of the future was too much to sustain.

Future Visions

Exemplifying overextension, Mattel Electronics' leadership pursued multiple visions for Intellivision's future, including 3D videogames, expansion into a networked home terminal, a portable system in collaboration with Sony, and working with GI, APh, Motorola, and even Magnavox to imagine and develop next-generation systems.[19] Long before Intellivision's test marketing in 1979, Hightower recalled that he and Richard Chang, then Director of Design and Development, "were already talking about the next generation. We sketched out what the next generation had to be, and I wanted to start right then." However, supporting Intellivision's development and launch occupied Mattel's attention. In March 1981 top leadership from Mattel and APh met to discuss new systems. Heather Edison (later Brendel), the office manager who eventually became APh's Chief Executive Officer, took notes. She recorded that Mattel "wants the product that can be manufactured by 1985–86 deliverable in 1983," noting that APh should propose two ideas, "a good but intermediate product that can be on the market in 1983" and a true successor system for later.[20]

Instead of developing one successor system, Mattel Electronics leadership pursued multiple systems. At one point there was an Intellivision II, III, and IV under development simultaneously. Intellivision II (known within Mattel Electronics as "Big Mac") became a compact, redesigned Master Component (chapter 8). Intellivision III (known within Mattel Electronics as "Coffee") was the intermediate system Edison noted, developed largely by APh with an improved CPU and graphics processor. Intellivision IV (known within Mattel Electronics as "Decade") was an ambitious system developed by Mattel Electronics' Strategic Development group headed by David Chandler. While only the cost-reduced Intellivision II came to market, Coffee and Decade articulated different visions for videogaming—a further iteration of Intellivision that would be backward compatible versus a radically new next-generation system.

In 1981 Chandler asked the engineer David Hostetler to head a development team (eventually the largest within Strategic Development) to design

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"a true next generation system" as Chandler explained it.[21] Originally called Intellivision II, this successor system had to be renamed when "Big Mac" was named "Intellivision II." Hostetler recalled his surprise when attending a company-wide managers meeting "and one day there was an Intellivision II. That's the first I heard of it." So, Hostetler proposed "Decade" for the new system, because "the design was going to last us ten years."

This lack of communication, multiplicity of systems and names, and duplication of efforts, exemplifies overextension. Roy Sasaki, an engineer who worked under Hostetler developing Decade's remote controller technology, emphasized the pitfalls of what he called an "internally competitive" atmosphere. Sasaki explained that he was not allowed to communicate with other development teams "because they didn't want us leaking information. Decade was internally proprietary. We couldn't even talk to other groups that were working on Coffee, and I barely heard about Coffee being developed."

If Decade would last ten years in the market, it needed to be state of the art. General Instrument (GI) proposed an upgraded CPU and video processor for Decade that would support three modes: a "'games oriented' system" with 320×192 resolution, a "text based system" supporting up to eighty characters per row, and an "Intelligent Terminal" mode for online communications.[22] Such an approach dovetailed with Chandler's desire to produce a system that could function as a home computer. However, Hostetler and Chandler decided against GI in favor of working with Motorola's 68000 processor, released in 1979 and used widely in the 1980s (for instance, in Apple's Lisa and Macintosh computers).[23] They had a sympathetic ear in Stav Prodromou, Mattel Electronics' Senior Vice President of Operations, who referred to Motorola engineers as "superstars of chip design" and who thought GI "had been way over the hill for many years." When reviewing GI's proposal, Hostetler mused in a memo, "As I move down Main Street towards Tomorrowland, a bus marked GI rushes past. But wait, they missed the turn."[24] Hostetler's joking allusion to Disneyland was apropos since he and Chandler were developing their own video processor—the Mattel Advanced Graphics Interface Circuit, or, simply, MAGIC.[25]

Mattel Electronics, a division of a toy company, intended to produce a state-of-the-art video processor. This was a heavy lift for an organization with a few years of experience in computers and electronics, so Mattel sought help from Motorola. However, the collaboration with Motorola was rocky. Though Mattel worked on MAGIC with Motorola throughout 1982 and early 1983, Hostetler recalled that the chip was only ever partially emulated, a "rack of breadboards" and "integrated circuits all connected together with wire wrap." While documentation for MAGIC existed and Motorola had estimated die sizes for the chip, in 1983 Motorola refused to finalize a contract

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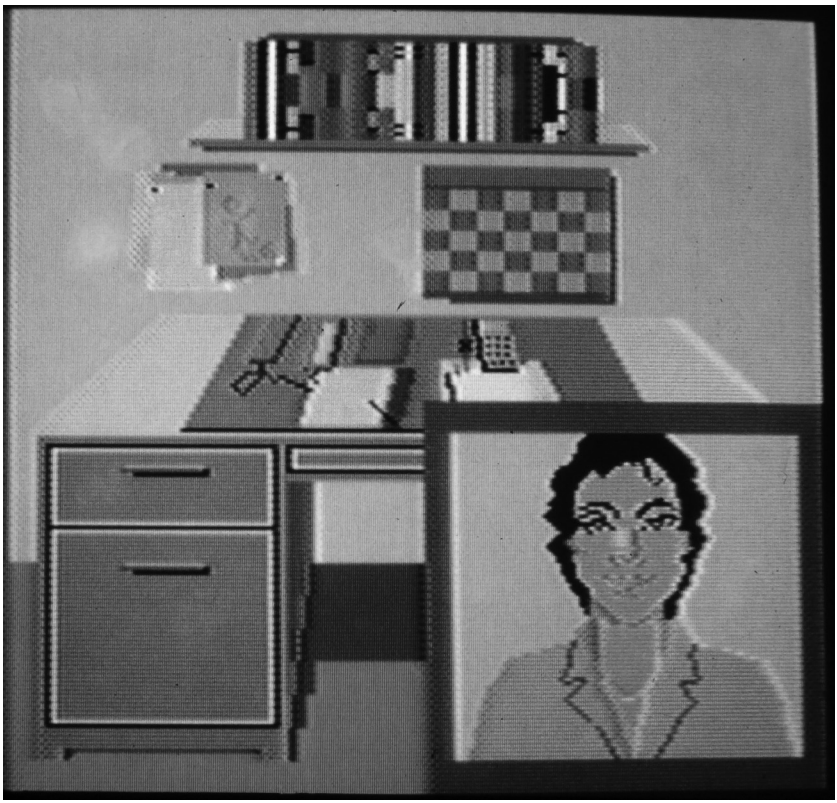
for chip production.[26] Prodromou noted that the company "did not have high confidence in Mattel's future plans and was unwilling to risk their other businesses to redirect resources."[27]

Prodromou also recalled how "tens of millions" of dollars were invested in Decade, though the system did not come to fruition. While on the road toward Tomorrowland, Mattel's "MAGIC" bus was a victim of the Crash when work on Decade was halted in late Summer 1983. It would have been a formidable machine, featuring a large selection of programmable colors, sixteen reusable moving objects (up to 16×16 pixels with four colors), a background resolution of 240×192, scrolling, support for 3D graphics, and a built-in modem for online gameplay: "A point-of-view two-person tank battle played over phone lines was talked about as a typical [Decade] application."[28] As with the Keyboard Component, Chandler had big dreams for Decade, calling it a "total system" that "encompasses entertainment,



13.2 Overall Project Laurie interface (Project Laurie images, Laurie Vertelney archive).

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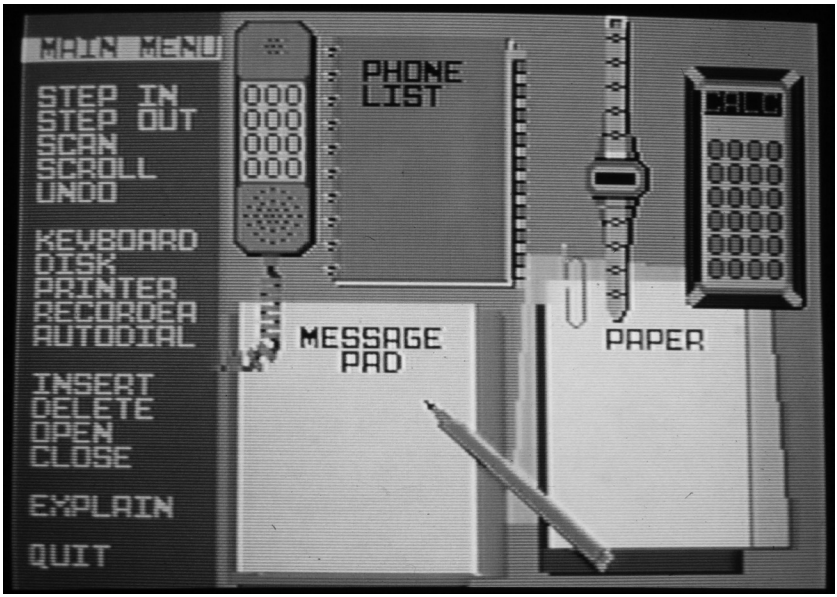
education, information, interactive transactions" and "the professional at home."[29]

Indeed, one project adjacent to Decade, developed by Industrial Designer Laurie McDaniel (later Vertelney) and Senior Technical Staff member Jerry Comisar, was imagining the future of home computing. This project was inspired by the Apple Lisa computer, released in January 1983, that featured an innovative graphic interface with desktop, files, and folders. McDaniel, hired in the summer of 1982, recalled that Chandler's group was "looking for ways to expand the Intellivision market beyond games. They were inspired by Lisa. And so I did some brainstorming and came up with a desktop metaphor for the Intellivision."[30] McDaniel's design became Project Laurie, founded in a "warm, personal approach" to computing invoking "work in a simulated home environment."[31] It would involve no typed commands but a "surrogate human guide" with a "realistic talking face" and "natural sounding digital speech" (figure 13.2).[32] McDaniel developed the graphics for this guide in her own likeness, with mouth movements synchronized to her digitized voice.

The overall interface was built around a desk with file cabinets and utility programs like a phone list and message pad on top (figure 13.3). On the wall behind the desk was a bookshelf of selectable software that



13.3 Project Laurie, close-up of desktop.

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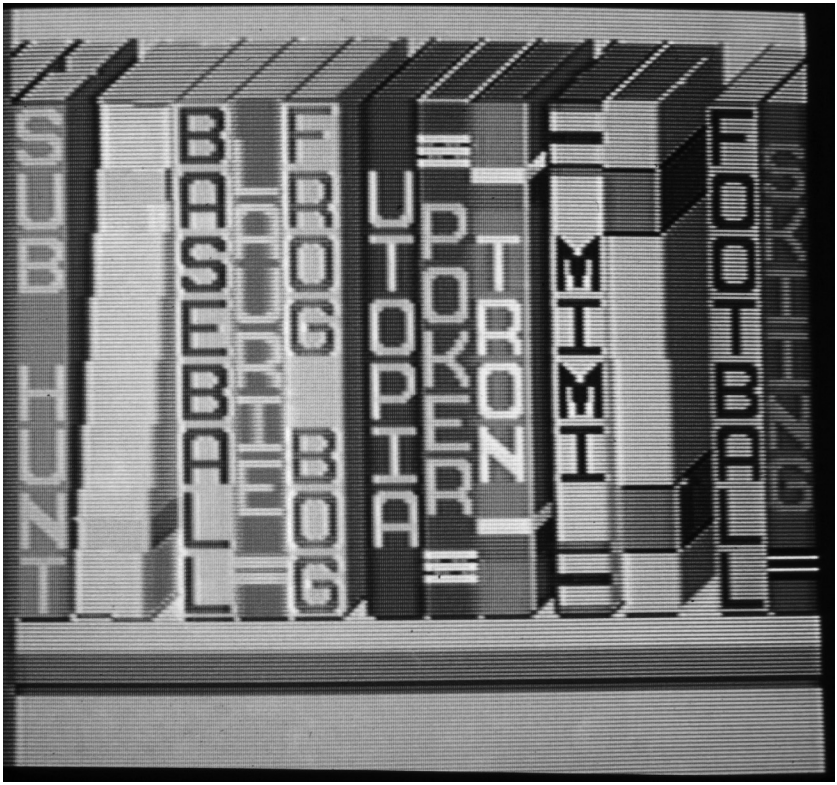
included Intellivision games like *Utopia* and *Skiing*, and Keyboard Component programs like *Conversational French* (which appears on the bookshelf as "Mimi," the main character who guides the user through French lessons; figure 13.4). A storyboard illustrating how Project Laurie might work begins with the hypothetical user selecting a message "from the kids" where the family sings "Happy Birthday" to "Daddy."[33] Later in the storyboard, the user receives a reminder, "time for French lesson," and Mimi's talking head appears and converses with Laurie. In a sense, Laurie was a next-generation version of the Keyboard Component's Mimi, articulating a future vision of self-improvement, productivity, and entertainment (chapter 3). While never released, Project Laurie reveals a feminized, natural-language computer interface found in contemporary contexts like Amazon's Alexa. It is no coincidence that McDaniel went on to work for Apple, helping develop the Siri personal assistant.



13.4 Project Laurie, close-up of software bookshelf.

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Chandler's vision for Decade, also seen in work like Project Laurie, clearly aimed to be in touch with tomorrow. However, this grand vision required time to unfold and like the Keyboard Component, it was unclear when (or if) the complex successor console would come to market (likely not until 1985 or beyond). As Edison's 1981 meeting notes indicated, Mattel Electronics leadership wanted an improved system quickly, and APh had been planning such a system since Intellivision's inception. This successor console was known internally at Mattel Electronics as "Coffee" and publicized as Intellivision III. It was developed at APh, with staff at Mattel's Applications Software helping develop videogames and a new EXEC.[34] While APh had been planning the successor system for some time, concerted effort began after Chandler's Keyboard Component was canceled in the summer of 1982.[35]

Unlike the Decade system, which was to transform home interactivity, Coffee embodied an iterative vision to augment console gaming. Indeed, according to preliminary specifications, the Coffee system would play existing Intellivision cartridges.[36] To achieve this, it would include an upgraded STIC graphics processor (which was designed by APh). The STIC 1B, as it was called, was intended to be "a dual mode device which contains specific hardware to support emulation of the Intellivision I system."[37] In emulation mode, the STIC 1B would play original Intellivision titles. In its caffeinated, upgraded mode, Mattel wanted the STIC 1B to support 4,096 colors and a screen resolution of 320×192 pixels (double the resolution of Intellivision I).[38]

During the last months of 1982, staff at APh and Mattel Electronics labored to prepare an Intellivision III exhibit for the January 1983 CES.[39] At Mattel Electronics, "three programmers and four graphics designers were occupied full-time for close to two months," with Group Leader Mark Urbaniec overseeing final preparations.[40] Don Daglow hailed Urbaniec as "the person who got Coffee software to CES. Given the assignment to 'make the software happen' on an impossible time line with incomplete machines, Mark [helped the group] develop game screens which interpreted the predetermined titles and suggested game play instead of just showing 'pretty pictures.'"[41] As Daglow's phrasing suggests, this "Coffee software" was not actual game cartridges but screens that suggested what those games might look like. Reflecting this, one attendee at CES recalled Intellivision III "displayed in a private room, by invitation only. Thanks to a friend at Mattel, I managed to see it. It's fabulous."[42] But looks deceived. Group Leader Keith Robinson later wrote that CES attendees "were looking at a plain old Intellivision displaying some really good graphics," since

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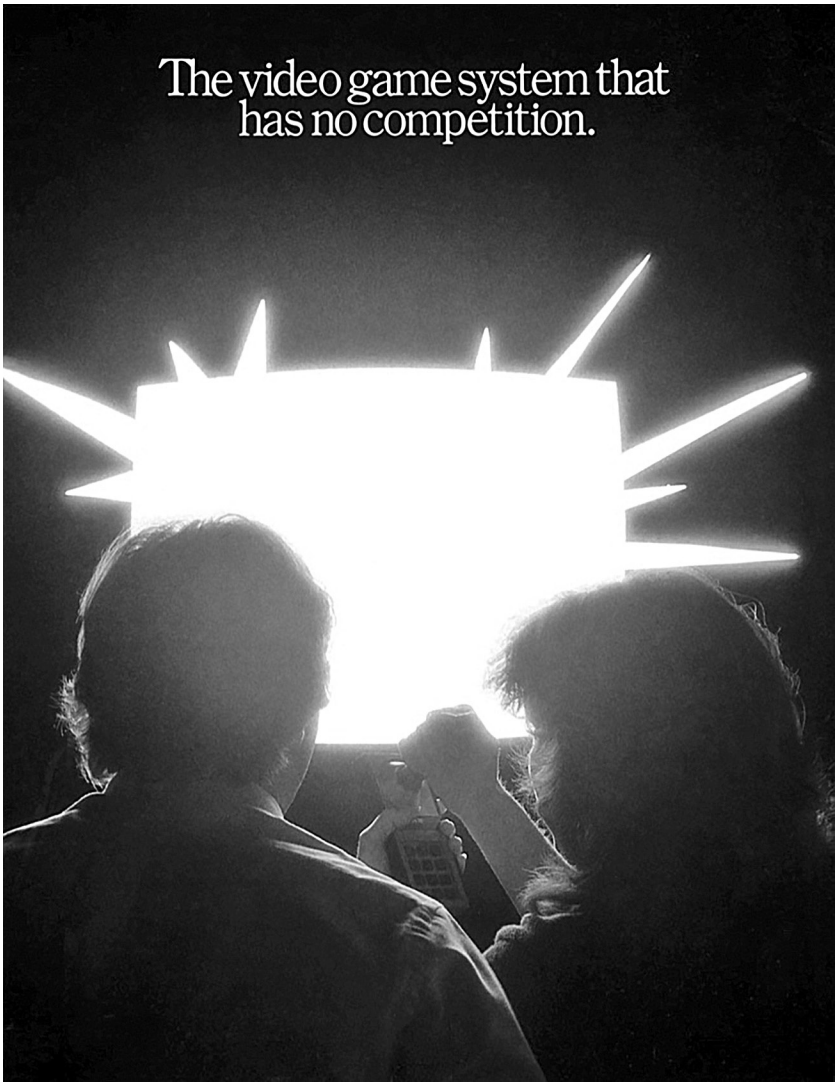

13.5 Image from Mattel Electronics 1983 brochure for Intellivision III.

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IF WE ATTEMPT BOTH 1B AND DECADE

NEW PRODUCT SCHEDULES.

1A (BIG MAC) - LATE 1982

NO SIGNIFICANT CONFUSION IF WE DO NOT CHANGE THE NAME.

IF WE DO:

SOME IMMEDIATE CONFUSION.

AGGRAVATES LATER CONFUSION.

1B - LATE 1983, EARLY 1984.

HAS TO BE IMAGED AS A NEW MODEL.

REQUIRES ADDITIONAL LINE OF SOFTWARE.

DECADE - MID 1984.

NEW MODEL.

REQUIRES ADDITIONAL LINE OF SOFTWARE.

CONFUSION IN THE MARKET PLACE.

THREE LINES OF INTELLIVISION SOFTWARE SIMULTANEOUSLY.

MUST CONTINUE 1A FOR VALID TWO PRICE POINT PRODUCT LINE.

1B BECOMES THE LUKEWARM IN BETWEEN PRODUCT.

13.6 Presentation slide about Coffee, which is labeled "1B" (David Chandler, "Decade," Paul Chandler archive).

Coffee "still hadn't progressed beyond the preliminary breadboard stage."[43] Indeed, the CES marketing brochure used to tout Intellivision III included hype and speculation, like the system supporting sixty-four moving objects. The brochure ended on the future-oriented claim that Intellivision III had "no competition"—a claim paired with an image of a white television screen, exploding with spectacular promise but devoid of content (figure 13.5).

Chandler also saw Coffee as an empty vision of the future. He warned that there would be "resource competition" between the Coffee and Decade systems, asserting that Coffee would end up being a "lukewarm" product and Mattel Electronics should "concentrate resources" on getting Decade to market (figure 13.6).[44] "If we try both," Chandler warned, "we get a 1984 product in 1985," suggesting that Decade would be late and product quality was being diluted by internal competition.[45] Chandler also feared that pursuing multiple systems simultaneously would create "confusion in the marketplace," requiring development of several software lines which would bewilder consumers while straining resources.[46] Despite Chandler's concerns, a spirit of overextension prevailed. A few years after Mattel Electronics had folded, an article described the chaos during 1983, noting how Mattel Electronics was causing "total confusion among the retailers" by touting Intellivision I, II, and III.[47] Chandler had been right.

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While enormous energies were expended on these possibilities, by early 1983 Intellivision was in trouble. The classic slogan "You can tell it's Mattel, it's swell" was once again in doubt. When Mattel reported it had lost more than $20 million in the fourth quarter of 1982, Spencer Boise, Vice-President of Corporate Affairs, reported that the "net loss was principally attributable to significantly increased price competition in the video game and related home computer industry."[48] Indeed, Mattel Electronics was facing numerous difficulties. Sales were down despite discounts. Revenues were squeezed. An overproduction of Intellivision cartridges created unsold inventory for retailers, and the entire videogame industry was facing "a glut of games, systems, and all the rest that the public just couldn't, or wouldn't absorb."[49] ColecoVision had stolen Intellivision's claim to being the most sophisticated console on the market, and Mattel Product Manager Al Nilsen noted that it was "taking more retail dollars from Mattel than Atari." Extensions like Intellivoice were struggling, and work on next-generation hardware and other projects was devouring resources. Mattel corporate explained that 1982 sales in the fourth quarter for Mattel Electronics were $44.8 million lower than the year before and expenses had skyrocketed $31.1 million, noting that this "was primarily attributable to significant advertising and rebate programs to promote consumer purchases of Intellivision and higher research and development expenditures by Mattel Electronics."[50] R&D was overextended, while expensive advertising tried to push inventory that would not move in a crowded market.

Momentum continued on next-generation systems like Coffee (Intellivision III) but did not last. Hightower and APh continued to develop Coffee after the January CES in 1983. Mattel Electronics produced marketing studies, and seminars were held, including one called "The Innards of Coffee" and another to brainstorm a Coffee version of *Night Stalker* to be programmed by Ray Kaestner.[51] "I can assure you that not a line of code got written on *Night Stalker*," Kaestner said. However, Toshiba had almost finished laying out the new graphics chip when Mattel Electronics halted hardware development in the summer of 1983. Hightower added that "the new Master Component was scheduled to be in production Christmas 1983. I had six fully functional emulators, and APh was on track to have a dozen cartridges ready by January 1984." It didn't matter. The climate had changed. Mattel Electronics did not have the capital to finance the product, and internal research said videogames were cold and computers were hot. As a result, Mattel Electronics poured Coffee into the sink, pinning its hopes on Aquarius and the ECS. At the June 1983 CES—around the time Aquarius

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was entering stores—Mattel Electronics announced Coffee's cancellation, disingenuously claiming that most of its features would appear on the ECS, slated for release in the fall.[52]

Mattel Electronics' inability to enter the home computing market before 1983 was likely an error. "Initially," writes Mirko Ernkvist, "the introduction of the home computer in 1977 had no large influence on the video game market, but as Moore's law continued and the market grew, the home computer had more and more of an effect."[53] For example, a 1982 commercial began with an apparent rivalry between Atari and Intellivision—directly referencing Mattel Electronics' famed George Plimpton commercials—but *Star Trek*'s William Shatner appeared with a Commodore VIC-20 home computer, touting its superiority to both. By 1983, home computers were the trendier product, with about one-third of videogame buyers considering purchasing one.[54] A March 1983 study from Mattel Electronics concluded that "purchase interest in home video games fell substantially" and "Intellivision should be marketed as an entertainment computer system rather than as primarily a video game."[55] However, between the Keyboard Component, the ECS, and Aquarius, Mattel Electronics was unable to compete in the home computer market.

The saturated market became increasingly evident during 1983. From February to April 1983, Mattel Electronics sales were only $22 million, compared to $119.4 million from February to April 1982.[56] Leadership responded with more discounts, and by June some retailers were offering Intellivisions for as low as $50.[57] For the quarter ending July 30, Mattel Electronics lost $201 million.[58] Discounting was proving unsustainable. Competitors discounted as well, and the strategy undermined a claim to value. Sharon Hartley, Director of Marketing for Intellivision, said, "What I was seeing was really disturbing. Pushing stuff out, from a brand standpoint, does not help. Mattel Intellivision software at $2 a cartridge as opposed to $12 a cartridge. What does that tell the consumer, that I can buy this stuff really cheap?" Another marketer, Gary Elliot, agreed that "the margins were eliminated. So there was little fuel for the kind of marketing efforts that we wanted to do, because everything now was just eating away at the momentum that Mattel Electronics had."

By mid-1983, industry observers began recommending selling Mattel stock, anticipating "a possible bankruptcy."[59] Even the Toy division, which continued to be profitable, was threatened. It was clear that more radical action had to be taken to right the ship. Thus, the boom's frenzied hiring at Mattel Electronics would be reversed. Director of Recruiting Dennis Marchand recalled meeting "with every Vice President because it involved only the highest-level people. We would map out what their department would look

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like with these people gone." The first of four large-scale layoffs took place on June 30, 1983.[60] Approximately 260 people were fired, about 15 percent of Mattel Electronics employees, representing the first staff layoffs since the founding of Mattel Electronics itself.[61]

On July 12, Denham stepped down as President of Mattel Electronics, followed by several other senior resignations.[62] Denham was replaced by Mack Morris, who in January had been hired into Mattel as President of the Diversified Companies Division.[63] Morris instituted sweeping changes, which included ending hardware development. Henceforth, Mattel Electronics would sell only hardware that was either released or in the final stages of development. Decade and Coffee were soon terminated, and most software production was "halted for a period of 're-think.'"[64] The consulting relationship with APh also ended. Hightower recalled that by September, "we were told that they wanted us to wrap everything up, submit our final bills."

The same day Morris became President, Terry Valeski was hired as the new Senior Vice President of Marketing and Sales at Mattel Electronics. Valeski had been a college classmate of Tom Kalinske, Senior Vice-President of Marketing who later became President of Mattel Toys, and they had both worked at the advertising agency J. Walter Thompson. In early 1983, Kalinske had contacted Valeski to "review the difficulties of the business and try to make some recommendations as to what to do next." Valeski explained the problem was that "hardware and software in the retail outlets were not moving. Toy retailers wanted to return it and they couldn't because it wasn't sold on terms that would allow you to return unsold merchandise." After the 1982 holiday season, Doepke recalled, "Toys "R" Us came to us and said, 'You've got to take back your unsold Intellivisions and videogames. And if you don't, we're going to return all the Barbies that we have as well.'" Mattel Electronics, the upstart division that for a time raised Mattel profits to new heights, had become a weight threatening to sink Mattel Toys—and Mattel's creditors could use this connection to compel radical change. Valeski explained that retailers exploited Mattel Electronics' status as a division of Mattel: "They decided, 'Well, if you won't let us return the Intellivision inventory we won't pay you for Barbie dolls and Hot Wheels and everything else, which caused a huge cash flow problem. The banks essentially said, 'You guys need to get out of the video game business.'"

Bankrupting Barbie

"In the end, Mattel Electronics just ran out of money," read an article printed a few years after the Crash.[65] Mattel Electronics had overextended

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itself. When you overstretch, injury results, and the strains of Mattel Electronics' businesses, its grand future visions, large workforce, and marketing expenditures were too much. It was also an overextension beyond the framework of toys, perhaps most apparent when Mattel Electronics bought a $12 million stake in the integrated circuit manufacturer Solid State Scientific in early 1983 (likely to facilitate its MAGIC graphics chip). Mattel Electronics was replaying the game of diversification that had led to its financial troubles in the early 1970s when it moved beyond the toy business with acquisitions and failures like the Optigan (chapter 1).

Mattel was always an innovative toy company, integrating technology into its toys from its beginning—perhaps one of its lasting legacies. However, technology had been in service to toys, not serving to grow beyond them. Mattel's foray into electronics dated back to the Optigan organ, extended to the toylike handhelds and programmable videogames, but then continued outward toward home computing, productivity, and even the design of their own complicated video processor. The microprocessor revolution of the 1970s promised to transform so much more than toys, and the cartridge ports of second-generation videogame platforms could be imagined as ports looking out over an ocean of digital possibility. To ignore such possibility—to abdicate the intelligent vision of the future—was to risk missing out on a chance to shape "the next major revolution to affect the American way of life," as Chandler envisioned.[66]

However, even as Mattel Electronics' massive losses threatened the whole company, the Toy division was thriving, not crashing. According to the *New York Times*, "Led by Barbie dolls, Hot Wheels cars and Masters of the Universe characters, [Mattel Toys] had its best year ever in 1983."[67] In a twist of fate, Mattel Electronics' separation from toys—a point of sometimes bitter jealousy and anger on the toy side—helped the Toy division wash its hands of electronics. "We are a toy company first, and you can quote me on that," President of Mattel Toys Ray Wagner said in late 1983.[68] When Mattel Electronics' downfall threatened to bankrupt Barbie, resulting in a downgrading of Mattel's credit rating, corporate pieced together a $400 million dollar loan from multiple banks to keep them afloat. Boise made it clear what the money was for: "It assures us, not only of the financial resources we need to run the business—the toy business—but enough to be progressive with it."[69] It was Mattel Toys' turn to separate itself from electronics, assuring retailers, bankers, investors, and the public that it would march strongly into the future while Mattel Electronics faded into the past.

Ironically, one of Morris's first acts as President of Mattel Electronics was to create a division, Mattel Technology Enterprises, "to develop significant new consumer businesses based on the creative use of emerging

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technologies."[70] Jeff Rochlis had been the first President of Mattel Electronics before departing to start his own computer business developing a portable device called the IXO, created by designers of handheld games at Parker Brothers. Morris brought Rochlis back as President of Mattel Technology Enterprises, which appears to have existed mainly on paper. On July 15, 1983, "sweeping through the Applications Software department like the Black Death through Europe, Rochlis briefly reviewed each game in development and gave it a thumbs up or down on the spot."[71] Rehiring Rochlis was in part a return to Intellivision's roots, as if Mattel Electronics had lost its way and Rochlis would guide the company home. However, it was Rochlis who had steered Intellivision away from toys toward the world of computing in the first place, embracing the modular extensibility of stereos and home computers to conceptualize Intellivision as a stepping stone to the larger world of computing. Rochlis's sudden reappearance symbolized the empty promise that Mattel's marketing magic could be their salvation. As mentioned in chapter 1, Rochlis was a perpetual promoter and consummate salesperson, but even his charisma could not return Mattel Electronics to profit. "Mattel's endless hype was crippling it," an industry observer noted later, and it did not have strong products to back up its hype.[72]

Under Morris, Mattel Electronics pivoted to developing software for other platforms, expanding its "multi-flavor" approach (chapter 12) since "with the game software market softening, computer software is the place to be."[73] Despite such efforts, 1983 losses reached $283.5 million by October compared to the $95.2 million profit for the January–October 1982 period.[74] Master Components could be found for as little as $9.95 after rebate.[75] A second layoff ensued, known informally as the "August Massacre," which affected about four hundred Mattel Electronics employees.[76] The *Los Angeles Times* reported employees "standing in the lobby of the firm's main electronics building, their arms loaded with personal belongings."[77] By this point, Marchand had established a protocol where supervisors would accompany laid-off employees and break the news: "Then I let the supervisor leave the room and believe me, they were so happy to get out of there!"

The atmosphere in Mattel Electronics was increasingly chaotic, disorganized, and gloomy. The programmer David Reichert recalled that "we all knew that the end was coming. Everybody was sitting around waiting." The unstable environment fostered its share of gallows humor, as with a cartoon, drawn by the Design Engineer Mark DiCamillo, showing hardware projects in a graveyard with the caption "Progress Status Report" (figure 13.7). Indeed, in late October Morris wrote a memo to management apologizing for a recent "indictment of our working habits," extolling the need "to control our 'downers'" and for "restoring positive psychic income to our

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13.7 Mattel Electronics "Progress Status Report" cartoon (by Mark DiCamillo).

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jobs and careers."[78] Despite these efforts at optimism, less than two weeks later a third set of layoffs took place. Key figures behind Intellivision's origin such as David Chandler and Richard Chang were gone. Mattel Electronics was now operating with a skeleton crew.[79]

To discuss the layoffs and boost morale, Gabriel Baum, Vice President of Applications Software, assembled the remaining programmers to make a speech. Baum began by recalling the Vogons from Douglas Adams's science fiction novel *The Hitchhiker's Guide to the Galaxy*, an unpleasant alien race prone to bureaucracy who demolish Earth to make way for an interstellar highway.[80] Baum told the programmers that the layoffs were "very Vogon-like behavior: I don't like it."[81] Baum's point was that rigid bureaucracy in the face of crisis was leading Mattel Electronics to pave over its core ethos of creativity. Baum had been hired to manage Mattel's team of creative programmers, cultivating a style of merging work and play (chapter 6). Extending this spirit, Baum asked the programmers to ignore the bad news and strive for "maximum creative and critical effort, hard work, all heavily spiced with fun."[82] However, Baum's paean to fun at this terminal stage was less about spurring innovation than using the rhetoric of play to assuage anxiety in the face of demoralizing uncertainty.

Projecting positivity and a bright future for Intellivision was important—to motivate the remaining employees and avoid sabotaging orders for the coming holiday season. In early November, Morris wrote separately to employees and retailers detailing the successes of Mattel Electronics' reorganization. The letters explained how they had removed the "glut of old inventory," returning focus to Intellivision in the wake of canceling the unsuccessful Aquarius computer after a few months on the market.[83] He marshaled anecdotes about Intellivision II's surge in orders, new videogames on the horizon, and the System Changer and ECS expansions already being sold out.[84] Morris's tone was exuberant, as if the 1983 holiday season would bring the gift of new life to Mattel Electronics. "The wind at last is at our backs," Morris wrote.[85]

At the corporate level, Mattel continued to assert a bright future for Intellivision. A November 1983 cover story in the industry magazine *Toys, Hobbies, & Crafts* reported that Mattel CEO Art Spear had recently addressed Mattel's future, stating "the personal computer field is not ending with Aquarius. In fact, the computer torch is being passed to Intellivision."[86] In truth, the wind at their backs had blown the torch out. Almost four years earlier, Intellivision had been test-marketed in Fresno with the promise of a Keyboard Component that never arrived. Now, the ECS add-on was being promised to extend Intellivision into the home computer market.

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In the same article, Ray Wagner, President of Mattel Toys, said that "Intellivision never started as a game machine, and I don't consider it a game machine."[87] As Mattel Electronics sped into the dark future, threatening to bankrupt Barbie, Intellivision was still being touted as a steppingstone to home computing.

But something had changed. While Wagner and Spear had plausibly made similar claims in 1979, by November 1983 this was mostly hype, promoting ECS for the holiday season but also boosting Intellivision and Mattel Electronics as still-relevant brands. With the growing market for computers, Intellivision (pitched as a computer, not videogame system) would entice potential buyers of Mattel Electronics. In truth, Intellivision's double vision—as game machine or computer—shaped its history. It was a videogame machine first and foremost, but for many who developed and promoted it, it was also an idea—an idea of a modular, extensible system that would expand beyond games. However, by late 1983 that ship had sailed. The intelligent vision of Intellivision was darkening. It was appropriate that the *Toys, Hobbies, & Crafts* issue ran with a cover image of the Titanic, with S.S. Mattel emblazoned on the helm (figure 13.8).

In the wake of fizzled holiday hopes and continuing losses, Mattel Electronics had a booth at the January 7–10, 1984 CES, but it was far smaller than before. Its unstated purpose was to entice outside offers.[88] Julie Hoshizaki recalled programmers remaining "optimistic because we had such good videogames coming out." Daglow, who by this time was working at Electronic Arts, recalled "seeing surviving members of our crew at the small, fairly primitive Mattel booth. They said, 'Yeah, we've been told we're going forward' and I'm thinking, 'Yeah, but we were also told the whole thing's going to blow.'" Hoshizaki's optimism evaporated after returning to Hawthorne and seeing a new sticker on the monitors and computers in their cubicles: it "didn't say 'Property of Mattel Electronics.' It suddenly said 'Property of Mattel Toys.'"

On Friday, January 13, 1984, remaining Mattel Electronics employees learned that they would be laid off on Friday, January 20.[89] The Quality Assurance engineer Dale Lynn recalled, "You'd go to work and where offices were, there were just piles of equipment. All the partitions were gone for the cubicles." The final Intellivision cartridge completed was David Stifel's "Game Factory," for which the last lines of code were written while Mattel Electronics, a factory of game making, powered down. "I thought, should I just let it sit?" recalled Stifel, "And everybody said, 'Nah, you're this far. Get it over the line—finish it.' So my last seven days there I just rushed and I finished it, I believe the day before we packed up our boxes and left."

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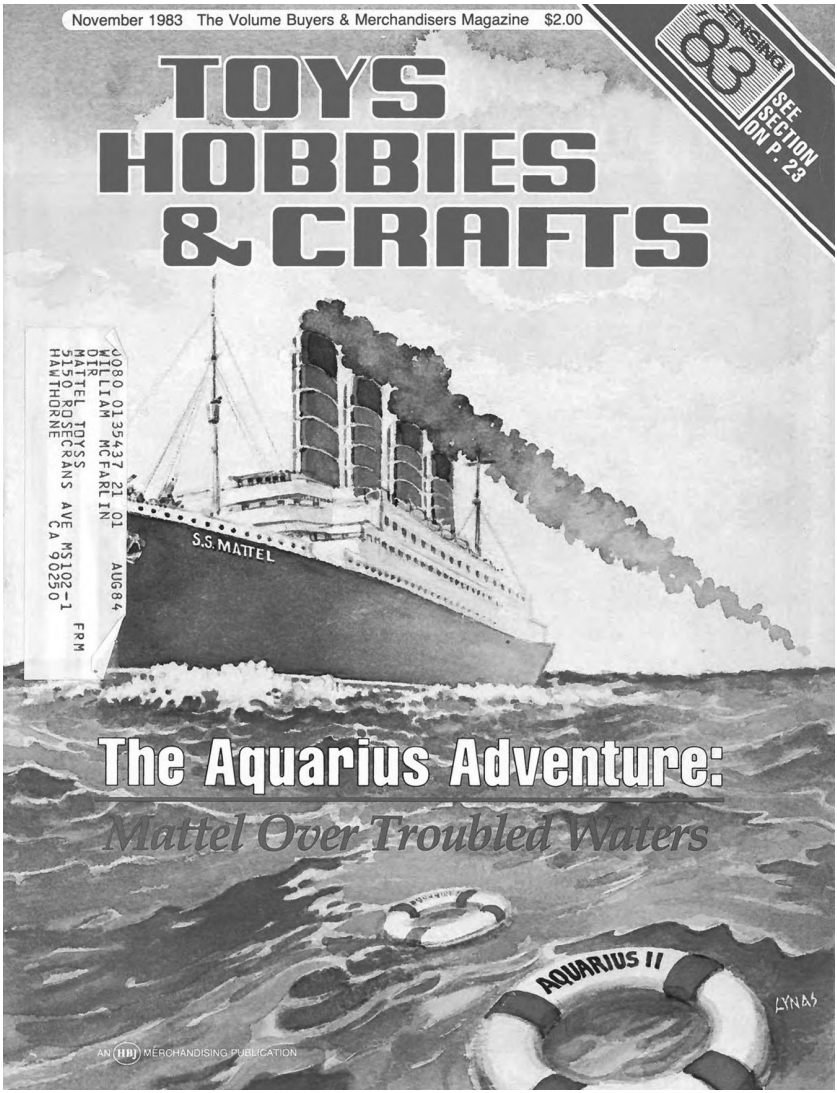

13.8 November 1983 cover of *Toys, Hobbies, & Crafts*. Blue Sky Rangers archive.

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Mattel itself—not just the Mattel Electronics division—was on the verge of bankruptcy. Kalinske noted it was saved only by a $231 million bailout from the venture capital firms Warburg, Pincus, and Co. and Drexel Burnham Lambert, where the legendary financier (and later convicted felon) Mike Milken was an executive.[90] "We had to go begging for capital, and our banks wouldn't talk to us anymore," said Kalinske: "They were so mad about what had happened with Intellivision. Milken said, 'I'll refinance you. Barbie should never go bankrupt.'"

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Aftercrash

Around 1987, the programmer and graphic designer Connie Goldman got a phone call from the programmer Dave Warhol. Warhol needed a road sign indicating a curve ahead for a conversion of the arcade game *Pole Position* for Intellivision. Warhol described what he needed "in great detail" but "when Connie sent me the graphic, it was an arrow pointing up!" Such a misunderstanding could never occur in the cubicle culture of an open-air office. However, this collaboration did not involve Mattel Electronics but INTV Corporation. By 1987, Intellivision game development was largely by telephone and fax. It was a new era.

The end of Mattel Electronics was not the end of Intellivision. Like Barbie, Intellivision survived the Crash of 1983. Terry Valeski, formerly Senior Vice President of Marketing and Sales at Mattel Electronics, bought the rights to Intellivision in January 1984. He recalled getting the idea after seeing continued interest in Intellivision at the January Consumer Electronics Show, adding the amount paid was closer to $10 million than the reported $20 million.[1] Mattel washed its hands of videogames, excising the malignant growth that almost consumed it. The connection between toys and videogames—a driving force of the US videogame industry—was finally severed. In a wry twist of fate, the destiny of Intellivision extended beyond the world of toys, but only through a smaller company struggling in the dark ages of US gaming before the arrival of Nintendo's and Sega's 8-bit consoles.

The new company, called Intellivision, Inc., obtained ownership of all work in development, which meant it could complete and create new games for the nearly three million Intellivision owners. The company became

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INTV Corporation in November 1984 when Valeski bought out his partners, explaining that the new name was "as much my initials as it was Intellivision."[2] INTV offered repair services and initially released completed or nearly completed titles, including *Thunder Castle*, *Hover Force*, and *Thin Ice*. Programmers, usually former Applications Software staff like Warhol and Goldman, were hired as remote contract workers to develop these titles. INTV's promotional materials explained that the company sought "to revitalize the home video game market" and that it was currently "the only U.S. manufacturer and distributor of home video game products."[3] In 1985, the company "achieved worldwide sales of $6 million" and delivered "750,000 software cartridges, and an estimated 50,000 hardware units."[4] INTV eventually released twenty-one games—all but six had been in development before the Crash.[5]

The Crash resulted from glut, overextension, inexperience, mismanagement, and consumer confusion in the marketplace—not because there was no longer interest in videogames. Indeed, "consumer demand does not go away," Valeski was quoted as saying in INTV's promotional materials. Videogames turned out not to be toys on a three-year cycle from fad to bust but a new medium destined to last.

With the boom years in the rearview mirror there was less capital to innovate, so INTV iterated, manufacturing a new Master Component after its stock of consoles depleted. But despite being named "Intellivision III," this was not the next-gen Coffee system discussed in the previous chapter.[6] Valeski passed on investing in the Intellivision system that APh had been designing, choosing instead another iteration of the original Master Component. This turn to the past also appeared in INTV's advertising, which extended Intellivision's early association with realism, sophistication, and sports. The materials invoked Intellivision's "historic role as an innovator of challenging and sophisticated video games" and referred to Intellivision's early sports titles as "industry standards and classics."[7] Only a few years on from the Crash, Intellivision's legacy was being written—and promoted.

Many remarkable Intellivision games were released by INTV, including improved sports games like *World Championship Baseball* and *Super Pro Football*. Nine "Super Pro Sports" games were developed, reanimating Intellivision's history with two-player sports titles going back to *Major League Baseball*. But with more cartridge space than the 4KD originals, this history could be transformed: the recurring super feature was a single-player mode. This augured a new horizon of play realism against computer opponents. In the case of *Slam Dunk: Super Pro Basketball*, for instance, the speed and accuracy of the computer opponents is derived from statistics of actual professional athletes.[8] Save for a few games such as *Checkers*, *USCF Chess*,

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and *Mind Strike*, artificial intelligence was not a focus at Mattel Electronics, given limited memory constraints.[9] The INTV sports titles were designed to make computer players seem "halfway intelligent," as *Slap Shot: Super Pro Hockey* programmer Ray Kaestner put it. For example, in *Super Pro Football*, the computer adversary selects plays by cycling through a menu, accompanied by sounds, as if a human player was making decisions.[10] This reflected a broader pattern where game AI involves "creating a sense of aliveness, the sense that there is an entity living within the computer."[11]

INTV eventually shut down in 1991, as the Age of Intelligent Television came to an end.[12] Just a year earlier, Ray Kurzweil had published his prescient book about artificial intelligence, *The Age of Intelligent Machines*, proclaiming that "the impact of this new age will be greater than the radical technological and social changes that have come before it."[13] This complicated history is still unfolding and being debated. Intellivision is not part of this emergent age, but its prehistory. Engineers and leadership at Mattel Electronics chased the dream of the home computer—catalyzed by gaming consoles—but did not materialize it. Yet Intellivision's sophisticated games, complex hand controllers, futuristic extensions, marketing magic, and embrace of realism were all part of an ecosystem of intelligence at a time when computers were entering the home. Beyond its existence as a videogame system bought, played, and enjoyed by millions, the idea of Intellivision was "stimulating primary demand," as Mattel marketers might have said. The idea of Intellivision did not simply generate interest in Mattel's console, but in a coming age of intelligent machines and the consumers who would buy into that future. A wide range of Intellivision games sent a tiny animated human running around the television's four walls to play sports, kill deadly robots, and slay purple dragons. Through their play, humans were becoming accustomed to seeing themselves—their intelligence—within the machine.

In the Intellivision game *Tron Maze-A-Tron*, players inhabit the role of Flynn, the programmer sucked into a computer in Disney's 1982 film *Tron*. Players explore circuit boards containing RAM and ROM chips as well as I/O (input/output) ports, and at the end they manipulate a bitstream of 1s and 0s to destroy the villainous Master Control Program (MCP). Intellivision was produced in the emerging era of network society, and *Maze-A-Tron* reflects excitement and anxiety regarding this computerization of culture. In this book, we entered Intellivision's platform culture, asking readers to become like the players of *Maze-A-Tron*—navigating the formations, practices, and extensions that shaped the story of a second-generation system.

Like Intellivision itself, we developed a modular approach that shaped our analysis in three primary ways. First, we embraced *a focus on both*

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platform principles and platform peripheries. This book is about the Intellivision system, not the Master Component. The Master Component's centrality reflects Intellivision's core platform principle—playing videogames. But this was the system's beginning, not its end. The Master and Keyboard Components articulated a joint platform future encompassing gaming and computing for the home. Later extensions modulated Intellivision into other domains. Within Mattel Electronics, these platform peripheries drew vast resources, reshaping organizational practices. A bias toward the best-sellers, the winners in the market race, is one reason Intellivision has received so little attention compared to Atari. Replicating this bias within the platform would severely limit our understanding of Intellivision's significance.

Second, we embraced *an attention to organizations and social relations*. Our modular approach extends beyond hardware and software, treating social organizations as platform principles and peripheries. For example, we can consider Mattel Electronics the "Master Component" of an interorganizational system that included Mattel Toys, which illuminates the importance of toys and marketing to videogame history. This system also included General Instrument and APh, without which Intellivision would never have existed, Ogilvy & Mather, without which Intellivision would never have succeeded, and peripheries like The PlayCable Company, which led Intellivision into the future. And this system absolutely included Atari, whose dominance shaped Intellivision game design and marketing.

Third, we embraced *a framework of specificity and generality*. Intellivision, taken as a systemic whole, is the "Master Component" of our analysis. We can, however, modulate to the second generation more generally. While there were differences between second-generation consoles and companies, there were also transplatform relationships that linked Intellivision, Atari, and others as modular elements in a sociotechnical milieu called the second generation of home videogame systems.

Our exploration of the Age of Intelligent Television has led us to many exciting discoveries, and we are not alone in our enthusiasm. The time of second-generation consoles, also the high point of arcades, is a focus of much contemporary retrogaming. There is a growing literature on nostalgia and videogames, some of which questions how nostalgia for early game cultures might implicitly invoke a time of white, male, heterosexual dominance in videogame play.[14] We do not want to make videogames great again, and an intersectional, modular approach is one way to locate nostalgia in broader frameworks, challenging a "narrow definition of platform studies" in favor of looking "to where the perceived boundaries of platforms break down or blur."[15] This allows for recognizing the joy of gameplay while situating nostalgia in horizons of economics, society, and cultural politics.

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The philosopher Walter Benjamin cautioned against nostalgia when emphasizing that the goal of historical analysis is not to discover a final truth but "take control of a memory, as it flashes in a moment of danger."[16] We live in a time when gaming is a multibillion-dollar global enterprise. As of 2023, 3.25 billion people play videogames, around 40 percent of the earth's population.[17] The Age of Intelligent Television might seem a universe away from our own, with its voracious social media, promises and dangers of artificial intelligence, and the metaverse. Yet it was during the second generation that many key cultural assumptions, technological protocols, and economic models were established. How might we take control of this past of play? How might we rewrite or destroy the MCP of history that reinstalls oppressive social relations? How might we use historically informed analysis, indeed a critical nostalgia, to forge more inclusive futures?

Intellivision may have battled Atari and almost bankrupted Barbie, but its platform culture also helps us rewrite these histories and futures. For instance, gaming culture could have been more diverse had Mattel built on its marketing expertise and programmer creativity to develop games for girls, a consumer demographic they knew existed and for which they had unmatched experience. Alongside videogames based on *Tron* (a classic image of the heroic male programmer and figure of nostalgia and "technomasculinity"), Mattel Electronics might have created videogames that engaged the imaginations of broader audiences.[18] Notions like play value and the Southern California ideology locate Intellivision's birth and development in a changing world of toys and entertainment. This challenges the idea that computation drives videogame history, providing a framework for considering the cultural, economic, and social forces central to contemporary digital transformations. A third example involves our transplatform approach, which reveals how Intellivision is, in a sense, not a platform at all. Like other systems, Intellivision was constituted through rivalry, extension, and everyday practice beyond any one game or console. Dissolving the fixed platform that is the usual object of historical nostalgia reveals a modular history of videogames. Such a history opens new avenues for rethinking ideas of "walled gardens" and "vertical integration" that threaten to seal emerging platforms from critical inquiry and open access.

Technology is always historical. In a sense, our past platforms the present and the futures we confront and choose. While understanding Intellivision illuminates the console and contributes to platform studies, our goal has been to provide tools for taking control of the past—to trace connections between culture and code, the materiality of chips and the consequentiality of marketing, everyday practices of design and future visions of home, work, and society.

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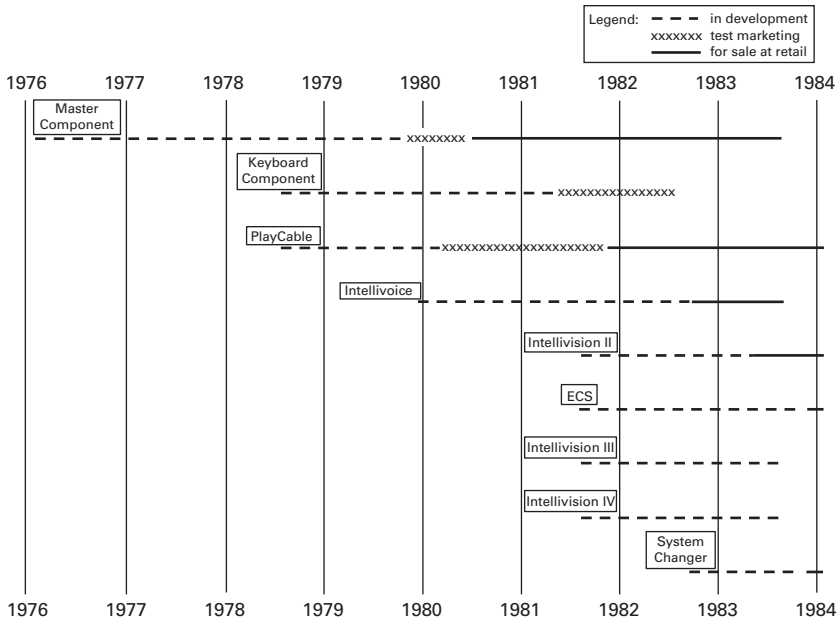
Appendix: Estimated Intellivision Hardware Timeline



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Notes

Introduction

1. Howard Polskin, "Behind the Scenes with the Blue Sky Rangers Who Dream Up Mattel's Video Games," *TV Guide*, June 19, 1982, 40.
2. Polskin was not at the park that spring day, but he included the story in his article after hearing about it during his visit.
3. Polskin, "Behind," 40.
4. Jacob Shelton, "TV Guide: History of the Most Popular Magazine of the '60s & '70s," *Groovy History*, April 3, 2021, https://groovyhistory.com/tv-guide-magazine-history/2.
5. Polskin, "Behind," 44.
6. In December 1980, the programmer John Sohl proposed a "future Intellivision game" named "Bombing Run" where players would command "a fighter-bomber on a strafing run over enemy territory" (John Sohl, "Some Ideas on Future Intellivision Games," December 6, 1980, National Videogame Museum archive). Six months later Sohl was part of a group proposing an "Air Traffic Controller" videogame, with one proposed variant involving an oil tanker docking at a foggy port (Bob Del Principe, John Sohl, and Peter Oliphant, "Intellivision Cartridge Using Voice Synthesis" [Idea Disclosure], June 5, 1981, National Videogame Museum archive). The programmer Bob Del Principe suggested turning it into a bomber videogame, "Flying Fortress," which was developed into *B-17 Bomber* by Sohl and two other programmers, William Fisher and Stephen Roney (Keith Robinson, "B-17 Bomber," *Blue Sky Rangers*, accessed August 14, 2023, http://history.blueskyrangers.com/mattelelectronics/games/b17bomber.html).
7. Keith Robinson, "Annotations to *TV Guide*'s article (June 19, 1982) about The Blue Sky Rangers," 1985, Blue Sky Rangers archive.
8. Robin Gerber, *Barbie and Ruth: The Story of the World's Most Famous Doll and the Woman Who Created Her* (New York: HarperCollins, 2009), 3. One memo from

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Chang called for a "Blue Sky Session" in Polliwog Park in Manhattan Beach on July 10, 1981. "Blue Skies" was used rhetorically with reference to the development of cable television dating back to the mid-1960s (Patrick Parsons, *Blue Skies: A History of Cable Television* [Philadelphia: Temple University Press, 2008, 238–246]).

9. Maaike Lauwaert, *The Place of Play: Toys and Digital Cultures* (Amsterdam: Amsterdam University Press, 2009), 21.
10. Tom Murn, "The Joy of Complex Things," *Playthings* 75, no. 3 (March 1977): 59.
11. Mattel, Inc., *Annual Report to Shareholders for the Year Ended February 1, 1975*, Hawthorne, CA, 1975, 34. Examples include board games like *Turning Point* (1969), *Mirror Mania* (1969), *Blarney* (1970), *Boundary* (1970), and *Jonathan Livingston Seagull* (1973).
12. "Gaming—Adults and Technology Enlivening Old Staple," *Playthings* 76, no. 6 (June 1978): 36, 38, 41–42.
13. "Gaming," 41.
14. "Mattel's Video Game," *Weekly Television Digest with Consumer Electronics* 18, no. 20 (May 15, 1978): 10.
15. David Chandler, "Video Game Specifications for General Instruments [sic]," (March 8, 1978), *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00015.pdf, 1.
16. "Which Game System Is Right for You?," *Electronic Fun with Computers and Games* 1, no. 1 (1982): 41–43.
17. One article from 1977 explained that videogame sales would be "reaching a peak in early 1979 and then declining because of inroads by home computers . . . Because playing games will be one of the functions provided by home computers, many students of the games industry feel that the TV game as an independent system may be short lived" (Jerry Eimbinger, "Trends in TV Games," in *Gametronics: The Electronic Game Designer's Conference* [Great Neck, NY: Electronic Engineering Times, 1977], 166–173, 166). See Ernie Smith, "When Video Game Consoles Wanted (and Failed) to Be Computers," *Vice*, May 22, 2017, https://www.vice.com/en/article/jpykgx/when-video-game-consoles-wanted-and-failed-to-be-computers.
18. VCS stood for "Video Computer System," which blurred the console/computer distinction.
19. David Chandler, "Intellivision History and Philosophy," 1982, https://papaintellivision.com/pdfs/CCF10232011_00016.pdf.
20. An appendix at the end of this book summarizes when Intellivision hardware was developed, test marketed, and released.
21. Nathan Altice, *I AM ERROR: The Nintendo Family Computer/Entertainment System Platform* (Cambridge, MA: MIT Press, 2015), 7.
22. Benjamin Nicoll, *Minor Platforms in Videogame History* (Amsterdam: Amsterdam University Press, 2019), 13.
23. Mirko Ernkvist, "Down Many Times, But Still Playing the Game: Creative Destruction and Industry Crashes in the Early Video Game Industry 1971–1986," in *History of Insolvency and Bankruptcy from an International Perspective*, ed. Karl Gratzer and Dieter Stiefel (Huddinge, Sweden: Söderstörns Högskola, 2008), 161–191.
24. Ernkvist, "Down," 169.

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25. Henry Jenkins, *Convergence Culture: Where Old and New Media Collide* (New York: NYU Press, 2006), 19.
26. Valerie Olson, *Into the Extreme: U.S. Environmental Systems and Politics beyond Earth* (Minneapolis: University of Minnesota Press, 2018), 6.
27. Tara McPherson has critiqued computational modularity in the development of UNIX in the 1960s as correlating with social and racial developments that sought to separate and isolate. Modularity was imbricated in "a world view in which a troublesome part might be discarded without disrupting the whole" (Tara McPherson, "U.S. Operating Systems at Mid-Century: The Intertwining of Race and UNIX," in *Race after the Internet*, edited by Lisa Nakamura and Peter Chow-White, (New York: Routledge, 2012), 26). Our systems approach, in turn, turns modularity on its head, demonstrating the intersectionality of cultural domains.
28. Alex Custodio, *Who Are You? Nintendo's Game Boy Advance Platform* (Cambridge, MA: MIT Press, 2020), 65.
29. Carl Therrien, *The Media Snatcher: PC/CORE/TURBO/ENGINE/GRAFX/16/CDROM2/SUPER/DUO/ARCADE/RX* (Cambridge, MA: MIT Press, 2019), 2.
30. Sebastian Deterding, "Toward Economic Platform Studies," 12th Annual Game Research Lab Spring Seminar "Money and Games," April 18–19, 2016, University of Tampere, 1. See Nick Srnicek, *Platform Capitalism* (Cambridge: Polity, 2017).
31. Marc Steinberg, "From Automobile Capitalism to Platform Capitalism: Toyotism as a Prehistory of Digital Platforms," *Organization Studies* 43, no. 7 (2022), 1073.
32. Michael A. Cusumano, *Staying Power: Six Enduring Principles for Managing Strategy and Innovation in an Uncertain World* (Oxford: Oxford University Press, 2010), 23, cited in Steinberg, "From," 1071.
33. Steinberg, "From," 1072, 1073 (emphasis in original).
34. Steinberg, "From," 1074.
35. The most extensive book about Intellivision is Lendino's *Space Battle*, a general overview of Intellivision's history, games, and hardware for a popular audience (Jamie Lendino, *Space Battle: The Mattel Intellivision and the First Console War* (Audubon, NJ: Steel Gear Press, 2024)).
36. Steven L. Kent, *The Ultimate History of Video Games* (New York: Three Rivers Press, 2001), 195–196.
37. Michael Z. Newman, *Atari Age: The Emergence of Video Games in America* (Cambridge, MA: MIT Press, 2017). See Ralph H. Baer, *Videogames: In the Beginning* (Springfield, NJ: Rolenta Press, 2005); Roberto Dillon, *The Golden Age of Video Games: The Birth of a Multi-Billion Dollar Industry* (Boca Raton, FL: CRC Press, 2011); Roberto Dillon, *Ready: A Commodore 64 Retrospective* (Singapore: Springer-Verlag, 2015); Tristan Donovan, *Replay: The History of Video Games* (East Sussex: Yellow Ant, 2010); Blake J. Harris, *Console Wars: Sega, Nintendo, and the Battle That Defined a Generation* (New York: HarperCollins, 2014); Leonard Herman, *Phoenix: The Rise and Fall of Videogames, 3rd edition* (Springfield, NJ: Rolenta Press, 2001); Alexander Smith, *They Create Worlds: The Story of the People and Companies That Shaped the Video Game Industry, Vol. I: 1971–1982* (Boca Raton: CRC Press, 2019). Some work appeared during Intellivision's heyday (Steve Bloom, *Video Invaders: Everything You Want to Know about Video Games Plus How to Beat Them!* (New York: Arco Publishing, 1982); Howard J. Blumenthal, *The Complete Guide to Electronic Games* (New York: New American Library, 1981); Craig Kubey, *The Winners' Book*

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of Video Games (New York: Warner Books, 1982); and George Sullivan, *Screen Play: The Story of Video Games* (New York: F. Warne, 1983).

38. Stephen Kline, Nick Dyer-Witheford, and Greig de Peuter, *Digital Play: The Interaction of Technology, Culture, and Marketing* (Montreal: McGill-Queen's University Press, 2003), 103.
39. Robert M. Bogursky, "A Home Video Game Cartridge Connector System: Interconnection Considerations and Techniques," in *Gametronics: The Electronic Game Designer's Conference* (Great Neck, NY: Electronic Engineering Times, 1977), 89.
40. Frost & Sullivan, *Electronic Toys and Games Market, Volumes I and II* [Report #893] (New York: Frost and Sullivan, 1981), 44.
41. Baer, *Videogames*; Dillon, *The Golden*; Donovan, *Replay*; Marty Goldberg and Curt Vendel, *Atari Inc.: Business Is Fun* (Carmel, NY: Syzygy Company Press, 2012); Herman, *Phoenix*; Kent, *The Ultimate*; Sheila C. Murphy, *How Television Invented New Media* (New Brunswick, NJ: Rutgers University Press, 2011); M. Newman, *Atari*; A. Smith, *They*.
42. Herb Brody, "Video Games Enter Technology Time Warp," *High Technology* 3, no. 4 (June 1983), 37.
43. Kent, *The Ultimate*, 185.
44. Murphy, *How*, 48; M. Newman, *Atari*, 49–51, 61.
45. Stephen Beck, "TV Game Design: Parameters, Pitfalls, Potentials," in *Gametronics: The Electronic Game Designer's Conference* (Great Neck, NY: Electronic Engineering Times), 1977, 129; see Lucas Hilderbrand, *Inherent Vice: Bootleg Histories of Videotape and Copyright* (Durham, NC: Duke University Press, 2009).
46. Don Lancaster, "TV Typewriter," *Radio-Electronics* 44, no. 9 (September 1973): 43–52; see M. Newman, *Atari*, 128–129.
47. Prince, "The Selling," 68.
48. Murphy, *How*, 41.
49. Murphy, *How*.
50. Carly A. Kocurek, *Coin-Operated Americans: Rebooting Boyhood at the Video Game Arcade* (Minneapolis: University of Minnesota Press, 2015), 4.
51. "*Play Meter* Survey Results: Videos Sweep to Big Gains in 1980," *Play Meter* 6, no. 21 (November 15, 1980), 26.
52. M. Newman, *Atari,* 8.
53. Nick Montfort and Ian Bogost, *Racing the Beam: The Atari Video Computer System* (Cambridge, MA: MIT Press, 2009), 14.
54. *Armor Battle* and *Auto Racing*. *Space Battle* has arcade-style gameplay in part, but also contains an extensive strategy component unlike arcade videogames.
55. David Chandler, in *Magnavox v. Mattel* (day 1 testimony), 80 C 4124 U.S. District Court, Northern District of Illinois, Eastern Division (July 6, 1982), 655.
56. Montfort and Bogost, *Racing*, vii.
57. Altice, *I*; Jimmy Maher, *The Future Was Here: The Commodore Amiga* (Cambridge, MA: MIT Press, 2012); Custodio, *Who*.
58. Therrien, *The Media*, 5; Dominic Arsenault, *Super Power, Spoony Bards, and Silverware: The Super Nintendo Entertainment System* (Cambridge, MA: MIT Press, 2017), 5. See also Custodio, *Who*; Julien Mailland and Kevin Driscoll, *Minitel: Welcome to the Internet* (Cambridge, MA: MIT Press, 2017); Anastasia Salter and John Murray, *Flash: Building the Interactive Web* (Cambridge, MA: MIT Press, 2014).
59. Steven E. Jones and George K. Thiruvathukal. *Codename Revolution: The Nintendo Wii Platform* (Cambridge, MA: MIT Press, 2012), 7.

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60. Dale Leorke, "Rebranding the Platform: The Limitations of 'Platform Studies,'" *Digital Culture and Education* 4, no. 3 (2012), https://www.digitalcultureandeducation.com/volume-43-papers/rebranding-the-platform-the-limitations-of-platform-studies, 259.
61. Leorke, "Rebranding," 265. Also see Thomas H. Apperley and Jussi Parikka, "Platform Studies' Epistemic Threshold," *Games and Culture* 13, no. 4 (2015): 349–369, https://doi.org/10.1177/1555412015616509.
62. Thomas H. Apperley and Darshana Jayemane, "Game Studies' Material Turn," *Westminster Papers* 9, no. 1 (2012), 12.
63. Tom Boellstorff, *Coming of Age in Second Life: An Anthropologist Explores the Virtually Human, Second Edition with a New Preface* (Princeton, NJ: Princeton University Press, 2015); Tom Boellstorff, Bonnie Nardi, Celia Pearce, and T. L. Taylor, *Ethnography and Virtual Worlds: A Handbook of Method* (Princeton, NJ: Princeton University Press, 2012); Braxton Soderman, *Against Flow: Video Games and the Flowing Subject* (Cambridge, MA: MIT Press, 2021).
64. Other platform studies scholars have faced these issues of ephemerality, materiality, and scope, as well as a massive archive making it "difficult to know when to stop searching" (Mailland and Driscoll, *Minitel*, 69).
65. A note on research ethics. Because our interviews were oral histories, they were not covered by human subjects protocols. We use interviewees' actual names, which is helpful when creators understandably wish to be recognized for their work (Boellstorff et al., *Ethnography*, 136–142). In a few cases where sensitive points were brought up, we have changed names and details to anonymize the discussion.
66. Ralph J. Watkins, *A Competitive Assessment of the U.S. Video Game Industry: Report on Investigation no. 332-160 Under Section 332(b) of the Tariff Act of 1930* (Washington, DC: United States International Trade Commission, 1984), xi. Most data from Mattel, industry publications, or the press either refer to US sales or do not specify if US or global sales are being reported.
67. See Boellstorff et al., *Ethnography*, Chapter 10; Nicole Starosielski, Braxton Soderman, and cris creek, "Amodern 2: Network Archaeology," *Amodern* 2 (2013), https://amodern.net/article/network-archaeology/.
68. Geert Lovink, *My First Recession: Critical Internet Culture in Transition* (Rotterdam: V2_Publishing/NaiPublishers, 2003), 11; see, inter alia, Apperley and Jayemane, "Game"; John Aycock, *Retrogame Archaeology: Exploring Old Computer Games* (Switzerland: Springer, 2016); Erkki Huhtamo, "Slots of Fun, Slots of Trouble: An Archaeology of Arcade Gaming," in *Handbook of Computer Game Studies*, ed. Joost Raessens and Jeffrey Goldstein (Cambridge, MA: MIT Press, 2005), 3–21; Nicoll, *Minor*; Laine Nooney, "A Pedestal, A Table, A Love Letter: Archaeologies of Gender in Videogame History," *Game Studies* 13, no. 2 (2013), https://gamestudies.org/1302/articles/nooney.

Chapter 1

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2. Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006), 3, 6.

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3. AnnaLee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1994), 7.
4. Manuel Castells, *The Rise of the Network Society, Second Edition with a New Preface* (Malden, MA: Blackwell Publishers, 2000), 419.
5. Lewis Mumford, *Technics and Civilization* (London: Routledge & Kegan Paul, 1934).
6. Lisa Messeri, "Greetings from Silicon Beach," *Anthropology News* 59, no. 6 (2019): 6–9, https://doi.org/10.1111/AN.1019.
7. "The Creative Idea" [Human Resources brochure], Mattel Electronics (1982), Blue Sky Rangers archive. The "concept engineer" term appears in "Resume of Richard S. Chang" (October 17, 1989), Winnie Chang archive.
8. Mike Davis, *City of Quartz: Excavating the Future in Los Angeles* (London: Verso, 1990), 18, 21.
9. Norman M. Klein, *The History of Forgetting: Los Angeles and the Erasure of Memory* (London: Verso, 1997): 94–101.
10. Davis, *City*, 48.
11. Morrow Mayo, cited in Davis, *City*, 17.
12. Sydney Ladensohn Stern and Ted Schoenhaus, *Toyland: The High-Stakes Game of the Toy Industry* (Chicago: Contemporary Books, 1990), 51; see Alexander Smith, *They Create Worlds: The Story of the People and Companies That Shaped the Video Game Industry, Vol. I: 1971–1982* (Boca Raton, FL: CRC Press, 2019), 395–397.
13. Robin Gerber, *Barbie and Ruth: The Story of the World's Most Famous Doll and the Woman Who Created Her* (New York: HarperCollins, 2009), 64. In 1947, Elliot and Ruth bought Matt's share of the business.
14. Gerber, *Barbie*, 15.
15. Gerber, *Barbie*, 15.
16. Gerber, *Barbie*, 87.
17. Nathan Paul Blair, Music Producing Unit, US 2504632, United States Patent and Trademark Office, April 18, 1950. Blair's patent built off Duncan's "copending" patent for the music box.
18. Ruth Handler and Jacqueline Shannon, *Dream Doll: The Ruth Handler Story* (Stamford, CT: Longmeadow Press, 1994), 74–75.
19. Jerry Oppenheimer, *Toy Monster: The Big, Bad World of Mattel* (Hoboken, NJ: Wiley, 2009), 23–24.
20. "Corporations: All's Swell at Mattel," *Time*, October 26, 1962, https://content.time.com/time/subscriber/article/0,33009,874558-1,00.html.
21. Gerber, *Barbie*, 3.
22. Cy Schneider, *Children's Television: How It Works and Its Influence on Children* (Lincolnwood, IL: NTC Business Books, 1989), 16, 22.
23. Schneider, *Children's*, 45.
24. Schneider, *Children's*, 16.
25. Handler and Shannon, *Dream*, 83; Stephen Kline, *Out of the Garden: Toys, TV and Children's Culture in the Age of Marketing* (London: Verso, 1993), 166.
26. Schneider, *Children's*, 21. While Hasbro aired a TV commercial for Mr. Potato Head in 1952 (Kline, *Out*, 166), Mattel's advertising partnership during "The Mickey Mouse Club" had a broader impact on the industry.
27. Schneider, *Children's*, 22.
28. Stern and Schoenhaus, *Toyland*, 55.

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29. Schneider, *Children's*, 22–23.
30. Handler and Shannon, *Dream*, 5.
31. Handler and Shannon, *Dream*, 11.
32. "Corporations."
33. Marc Steinberg, "From Automobile Capitalism to Platform Capitalism: Toyotism as a Prehistory of Digital Platforms," *Organization Studies* 43, no. 7 (2022): 1069–1090.
34. Schneider, *Children's*, 37–38.
35. Gerber, *Barbie*, 88.
36. Gerber, *Barbie*, 88; "Corporations."
37. Handler and Shannon, *Dream*, 133–134; Gerber, *Barbie*, 158.
38. Gerber, *Barbie*, 155.
39. Stern and Schoenhaus, *Toyland*, 70.
40. G. Wayne Miller, *Toy Wars: The Epic Struggle Between G.I. Joe, Barbie and the Companies That Make Them* (New York: Times Books, 1998), 84.
41. Gerber, *Barbie*, 162.
42. Gerber, *Barbie*, 160.
43. Larry Crane, "Pea Hicks: Optigan Life," *Tape Op*, Issue 137, May/June 2020, https://tapeop.com/interviews/137/pea-hicks/. Mike LeDoux, a sound engineer who worked on talking Barbie toys, was responsible for designing the Optigan's optical discs (Pea Hicks, "Mike LeDoux at the '74 CES Show," *Optigan.com*, accessed Feb 11, 2024, https://optigan.com/info/optigan/employees/mike-ledoux/).
44. Gerber, *Barbie*, 160.
45. Candi Strecker, "The Optigan," in *The Dead Media Notebook: 20th Anniversary Edition*, ed. Bruce Sterling, Richard Kadrey, Tom Jennings, and Tom Whitwell (London: Music Thing Press, 2015), 258–261. See Pea Hicks, "Optigans Anonymous," accessed August 8, 2023, https://optigan.com/about-pea-hicks/optigans-anonymous/.
46. Gerber, *Barbie*, 173.
47. "New Bosses Tackle Mattel's Troubles," *Forbes*, September 15, 1972: 40.
48. Handler and Shannon, *Dream*, 147.
49. Stern and Schoenhaus, *Toyland*, 71; Smith, *They*, 398–399.
50. Danielle Gelehrter, "Opening the Vault Interviews: Derek Gable—Mattel Director of Preliminary Design," *He-Man.Org*, (January 19, 2014), https://www.he-man.org/forums/boards/showthread.php?248369-Interview-with-Derek-Gable-Former-Director-of-Preliminary-Design.
51. Joan L. Herman, "Research and Development in the Toy Industry," *Performance Improvement* 21, no. 4 (1982): 36–38, doi.org/10.1002/pfi.4170210417.
52. The six directors were Chang, Gable, Kilroy, Steve Lewis, Alan Pitkanen, and Susannah Rosenthal.
53. Chang, "Resume."
54. Chang, "Resume."
55. For instance, John W. Ryan and Richard Shih-Teng Chang, Clutch Device for Sound Reproducing Means, US 3450239, United States Patent and Trademark Office, June 17, 1969; John W. Ryan and Richard S. Chang, Device for Reproducing Recorded Sounds in Toys, US 3582084, United States Patent and Trademark Office (June 1, 1971).

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56. Richard S. Chang, Denis V. Bosley, and Manfred Roessler, Programmable Free-Flight Toy Aircraft, US 3803758, United States Patent and Trademark Office (April 16, 1974).
57. Chang, "Resume."
58. David James, "Electronic Game Concepts," January 26, 1976, David James archive (DJA).
59. Smith, *They*, 400.
60. Smith, *They*, 400.
61. Davis, *City*, 55.
62. Davis, *City*, 57.
63. James, "Electronic."
64. Richard S. Chang and George J. Klose, Obstacle Game, US 4162792, United States Patent and Trademark Office (July 31, 1979); Chris Barnett, "Mattel Rises. Again," *Los Angeles Magazine* (December 1985): 268–273, 333–334.
65. Dan O'Dowd at APh also helped with the Football prototype. The 6502 code for Football from APh was included in the patent eventually filed for handhelds (Chang and Klose, Obstacle Game).
66. Jerry Henn, "Mattel—Dave Jones [sic], Dev. Engrg" (Memorandum to Ray Ottenmiller), May 27, 1976, DJA. See Smith, *They*, 401.
67. Scott Stilphen, "DP Interviews Mark Lesser," *DP Press*, https://www.digitpress.com/library/interviews/interview_mark_lesser.html; John Denker, Untitled 6502 code with note from George Klose, September 3, 1976, https://www.seanriddle.com/fbprotosm.pdf. Lesser may have converted the 6502 assembly language for the prototype games from APh into the assembly language needed for the 4-bit chips.
68. Glenn Derene, "Game Boy's Grandfather: Remembering the First Handheld Games," *Popular Mechanics* (October 1, 2013), https://www.popularmechanics.com/culture/gaming/a9459/game-boys-grandfather-remembering-the-first-handheld-games-15987495/.
69. Smith, *They*, 470–471.
70. Barnett, "Mattel," 270.
71. Frost & Sullivan, *Home and Coin Operated Electronic Games* [Report #650] (New York: Frost and Sullivan, 1979), 65. In March 1977, Mattel Electronics planned to produce 362,000 *Auto Race* and 325,000 *Football* handhelds, with options for 100,000 more each and deliveries by air if needed; a smaller number of another handheld, *Missile Attack*, were also planned (Jeff Rochlis, "Mattel Electronics Line Status Report for 1977," March 2, 1977, DJA.).
72. Tom Zito, "Playing a Calculated Game," *The Washington Post* (October 20, 1977), https://www.washingtonpost.com/archive/lifestyle/1977/10/20/playing-a-calculated-game/37e7d080-087a-4811-84e9-8d40647e3d5c/. In 1978, the *Football* handheld remained the hottest toy for several months after Christmas, an anomaly for the toy market when sales usually decline after Christmas.
73. "Toying With Electronics," *Weekly Television Digest with Consumer Electronics* (*WTD*) 19, no. 9 (February 26, 1979): 10; Frost & Sullivan, *Home*, 66; "Non-video Electronic Games Taking Off," *WTD* 19, no. 7 (February 12, 1979): 8; Smith, *They*, 402.
74. Rochlis, "Mattel." In 1980, Chang referred to "setting up the 'First' Mattel Electronics group in 1977" (Chang, "Facility"; Chang, "Resume").

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75. See Smith, *They*, 470–474.
76. "Consumer Electronics Personals, October 2, 1978," *WTD* 18, no. 40 (October 2, 1978): 14.
77. Rochlis, "Mattel."
78. Chang and Klose, Obstacle Game.
79. Tom Murn, "The Joy of Complex Things," *Playthings* 75, no. 3 (March 1977): 59.

Chapter 2

1. One headline from Winter CES read "Toy Industry Marching into Video Games," with an observer reporting that the "next major assault on blossoming video game market will come from toy & game industry." Mattel was named as one of the toy companies "known to be looking hard at field" and "talking with semiconductor suppliers;" a Mattel spokesman was quoted, saying "we have a reasonably good understanding" of the emerging videogame field, "and it's not totally foreign to us" ("Toy Industry Marching into Video Games," *Weekly Television Digest with Consumer Electronics* [*WTD*] 16, no. 3 [January 19, 1976]: 9).
2. "Everybody's Playing Games," *WTD* 16, no. 2 (January 12, 1976): 11.
3. Ralph H. Baer, *Videogames: In the Beginning* (Springfield, NJ: Rolenta Press, 2005), 124.
4. Ethan Johnson, "The Historiography of Video Games: Part 1," *The History of How We Play*, June 8, 2018, https://thehistoryofhowweplay.wordpress.com/2018/06/08/the-historiography-of-video-games-part-1/.
5. Ronald L. Baldridge, "Applying the F8 Microcomputer Family to Games," in *Gametronics: The Electronic Game Designer's Conference* (Great Neck, NY: Electronic Engineering Times, 1977), 60.
6. "We're Not Just Playing Games" [job advertisement], Mattel Electronics [undated], attached to "Approach Letter" (David Chandler, March 31, 1977), Paul Chandler archive (PCA).
7. David Chandler, "Approach Letter," March 31, 1977, PCA.
8. David Chandler, in *Magnavox v. Mattel* (day 1 testimony), 80 C 4124 U.S. District Court, Northern District of Illinois, Eastern Division (July 6, 1982), 652.
9. Chandler, in *Magnavox*, 668.
10. Chandler, in *Magnavox*, 667.
11. David Chandler, "Intellivision History and Philosophy," 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00016.pdf, 2.
12. Chandler, in *Magnavox*, 668–669.
13. Chandler, in *Magnavox*, 672.
14. Chandler, "Intellivision."
15. Chandler, "Intellivision." GI engineer Stephen Maine explained that their STIC chipset always had graphics RAM so programmers could include their own graphics. Maine's hypothesis was that Chandler likely meant the cost of the GI chipset did not include graphics RAM because GI did not manufacture chips that would be used for this RAM (email to authors, July 14, 2023). However, it is unclear what chipset Chandler saw at the June 1977 CES, and what its functionality might have been. GI's 1977 chip catalog did not mention graphics RAM in its description of GI's programmable game set, explaining that the system would generate its output from

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graphics ROM containing "a large variety of game symbols" (*1977 GI Microelectronics Data Catalog* [Hicksville, NY: General Instrument Corporation, 1977], 4B-38.)

16. Chandler, "Intellivision."
17. Maine also recalled that GI had met with Nolan Bushnell in 1976, on the very day Warner Communications's acquistion of Atari was announced. Bushnell declined, given Atari's own console. GI then approached Coleco, Milton Bradley, and Mattel.
18. *1977 GI*, 1-18.
19. An August 1977 image from *Electrical Engineering Times* shows Harrower with a breadboarded system ("Semiconductor Manufacturers Shift Emphasis from Microprocessors to Highly Sophisticated LSI Circuits," *Electronic Engineering Times*, August 22, 1977, 1). See Tom Mariner, "When Videogame History Called, Player One Was Ready," *Innovateli*, June 18, 2021, https://www.innovateli.com/when-videogame-history-called-player-one-was-ready/.
20. Chandler, "Intellivision."
21. Bernie Rohrbacher, Telegram to Josh Denham/Howard Cohen at Mattel (November 18, 1977), *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00000.pdf. Magnavox was manufacturing a home pinball machine for Mattel Electronics, which suggests a connection. By April 1978, the plan was for Magnavox to manufacture five thousand consoles a week that October ("Video Game Plan," Magnavox [April 12, 1978], *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00009.pdf). Magnavox backed out from working with Mattel, perhaps because of chip delays with GI (Laury Scott, email to authors, October 24, 2021). Moreover, Magnavox was developing the Odyssey^2 system in 1978 and may have wanted to focus on their own projects. After Magnavox decided not to manufacture the Intellivision system, Mattel worked with Sylvania to manufacture systems under their brand, which would be available on the East Coast.
22. "TV Games," *Merchandising* (June 1978): 38. See "Mattel Debuts Its Electronic Cartridge Video System," *Merchandising* (June 1978): 48; Kent Wall, "Sales Meeting and CES—June 7–15, Revised Schedule" [Memorandum] (May 19, 1978), *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00010.pdf.
23. Mattel Game Scratched," *WTD* 18, no. 24 (June 12, 1978): 13.
24. Bryan Roppolo, "The Milton Bradley Company: Their Partnership with Texas Instruments and Other MB History," *AtariAge*, January 25, 2010, https://atariage.com/forums/applications/core/interface/file/attachment.php?id=773690.
25. Chandler, "Intellivision."
26. David Chandler, "Assessment," October 12, 1978, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00005.pdf.
27. By September 29 "Intellivision" appeared in a memorandum: "Mattel/Sylvania/General Instrument Meeting, Held on 9-27-78, Concerning Intellivision (Video)" [Memorandum], Mattel Electronics (September 29, 1978), *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00008.pdf.
28. Ed Krakauer, email to authors, December 1, 2019.
29. "APh Notebook" [office notebook], Heather Brendel archive (HBA).
30. Frost & Sullivan, *Home and Coin Operated Electronic Games* [Report #650] (New York: Frost and Sullivan, Inc., 1979), 31.
31. David Chandler, "Video Game Specifications for General Instruments [sic]," (March 8, 1978), *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10

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232011_00015.pdf, 1; "Development Agreement," June 29, 1978, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00001.pdf.

32. Occasionally the STIC is called the Standard Television Interface Circuit.
33. David Rolfe, "Your Friend, The EXEC" (Mattel, Inc., 1978; Edition 2.0, 22 June 22, 1981), Blue Sky Rangers archive (BSR), 2-4.
34. Ken Greenberg, "8900 System Schedule," July 28, 1978, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00001.pdf; "Development." Some internal GI documents called the system the "STIC system," explaining it "uses two processor configurations, a game rules processor using [Intellivision's] CP1610 and a graphics picture processor using the STIC" (Duncan Harrower, "AY-3-8900 STIC System Notes," General Instrument, December 6, 1977, Stephen Maine Archive).
35. Duncan Harrower, email to authors, September 12, 2020.
36. Nathaniel Lockhart, "Interview with Gilbert Duncan Harrower, Inventor of the 'Pong-on-a-chip,'" *The Geekiverse*, January 25, 2019, https://www.gamingalexandria.com/wp/2022/01/gilbert-interview/. The chip sold for $5–$6 ("Video Games Selling under $65 Retail," *WTD* 15, no. 48 [December 1, 1975]: 8).
37. *1977 GI*, 1-16; David Winter, "Pong-In-A-Chip" (2018), https://www.pong-story.com/gi.htm. See Lockhart, "Interview"; George Rostky, "The 30th Anniversary of the Integrated Circuit: Thirty Who Made a Difference," *Electronic Engineering Times* (September 1988). This chip was followed by many others, like GI's AY-3-8700 "Tank Chip," designed by Maine.
38. Stephen Maine, email to authors, September 3, 2020.
39. In 1977, GI's Microelectronics catalog listed their "GIMINI Programmable Game Set," including the STIC and listing key system features like "eight moving screen objects," recording interactions between these objects, and a "moveable background field" (*1977 GI*, 4B–39). In 1978, GIMINI was presented in three versions from which potential partners could choose (*GIMINI TV Game Circuits* [Hicksville, NY: General Instrument Corporation, 1978], 60). An "economy" version had cartridges but no CPU, with a simple color processor to prepare video output. A "mid-range" GIMINI system had a CPU and a GIC (Graphics Interface Circuit) that did not support moving objects or programmer-supplied graphics. The third, "full range" version was "based on two processors," a CPU and the STIC, thus identifying the architecture that would become Intellivision. GI's economy systems were produced by multiple companies and became known as the PC-50x family of consoles. The mid-range system was brought to market in 1978 by Unisonic Product Corporation as the Champion 2711; this rare console is sometimes called "Intellivision's Little Brother" because it shares features with its more powerful sibling.
40. Rolfe, "Your," 2-4.
41. In truth, the process is more complicated. The NTSC (National Television Systems Committee) broadcast signal sends 525 scanlines, but the electron beam paints only the odd or even scan lines in one pass, thus creating an interlaced image consisting of two half-frames that display 262.5 scanlines of information. For television images, these two half-frames are drawn thirty times a second each, thus painting the total image sixty times a second (at approximately 59.94 Hz). This interlacing reduces flicker by allowing the blended image to be displayed sixty times a second. Second-generation video game systems like Intellivision use a de-interlaced image, telling the television to only paint half the frame. So

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instead of painting two, slightly offset frames thirty times a second, the STIC tells the television to paint only the odd scanlines, sixty times a second.

42. Rolfe, "Your," 2-4.
43. Moving objects are now sometimes called "sprites." Neither Intellivision nor Atari programmers used this terminology, though "sprite" was used at TI to describe objects generated by the TMS9918 chip.
44. Harrower, "AY-3-8900."
45. When Hightower and Rolfe ran out of ideas for images to put in GROM, Rolfe wrote EXEC programs he called GROMFK ("GROM fuck"), which he stuck into the remaining space of the GROM chip. The name GROMFK indicates an illicit use of the memory space that screwed with GROM's intended use. The routines allow programmers to create graphics cards procedurally, like drawing lines with an "imaginary pencil" (Rolfe, "Your," C-4).
46. John Sohl, "Four Major Important Hardware Parts" [untitled memorandum], October 31, 1980, BSR.
47. David Rolfe, email to authors, April 19, 2021.
48. GRAM did not need to be so limited. The Intellivision II GRAM chip allocated 1 KB of storage instead of 512 bytes, but the hardware disables access to the additional GRAM so original videogames function (Joe Zbiciak, "Intellivision Hack of the Weekend: 128 GRAM Tiles," June 13, 2010, https://groups.io/g/intvprog/topic/56960066#5862).
49. The EXEC operating system uses most of this memory to store key variables used by the operating system and maintain a memory stack for use by the CPU.
50. The STIC chip supported different display modes, including a rarely used Colored Squares Mode (used in *Snafu* for example). This mode "operates by taking an individual 8×8 pixel card and redefining it as four 4×4 pixel squares. Each of these squares can be programmed separately to one of eight colors" (Harrower, "AY-3-8900-1: Customer Procurement Specifications," April 29, 1982, 6.9, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00012.pdf).
51. In the early 2020s Western Process Digital was still advertising parts for the TDC-2000, including the WPCP1600, which emulates the CP1600, since "new CP1600 chips have not been manufactured [since 1985]" ("WPCP-1600," Western Process Computers, accessed August 10, 2023, https://westernprocess.com/ftp/WPCP1600.pdf). CP1600s may remain in use: as late as 2021 Kimberly-Clark still used TDC-2000 control systems for toilet paper manufacturing (Jim Montague, "Kimberly-Clark Rebuilds Tissue Machine Despite COVID-19," *Control Global*, November 18, 2020, https://www.controlglobal.com/industrynews/2020/af-at-home-16/).
52. "GI & Honeywell Announce Joint Venture," *Microcomputer Digest* 1, no. 10 (April 1975): 4. In 1975 Honeywell TDC-2000 control systems using the CP1600 "were installed at Exxon's Sarnia, Ontario refinery, Kennecott's Garfield, Utah copper smelter, and other sites" (Terrence K. McMahon, "Three Decades of DCS Technology," *Control Global*, April 18, 2005, https://www.controlglobal.com/articles/2005/227/).
53. Though neither could be verified, Maine explained that the CP1600 was "designed for Honeywell to control systems in nuclear reactors" (email to authors, February 5, 2019), and Charles Dages recalled that the chips might have been used in anti-submarine aircraft control systems.

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54. Nathaniel Lockhart, "Interview with Stephen Maine, Early Video Game Pioneer and Creator of Intellivision Graphics," *The Geekiverse*, April 28, 2020, https://web.archive.org/web/20200513055234/https://thegeekiverse.com/interview-stephen-maine-early-video-game-pioneer-creator-intellivision-graphics/.
55. The 1.79 MHz is for NTSC television systems used in the United States. There is debate regarding the correct way to define the CP1610's speed (decle, "INTV Clock," *AtariAge*, May 24, 2016, https://forums.atariage.com/topic/253007-intv-clock). *GI Microelectronics 1978 Data Catalog* lists it as 1.79 MHz (60). Yet, the slower 894.886 kHz speed is actually the rate that determines the CPU's microcycle, which determines how CPU instructions are counted. Television sets of the period required the signal frequency for a color image to be 3.579545 MHz. Because the STIC ran at this speed to align with the TV, in theory the CPU could have run faster. GI experimented with faster CPU speeds but were unsuccessful (Stephen Maine, email to authors, September 2, 2020).
56. Stephen Maine, email to authors, February 4, 2019.
57. The delay registers were used for other visual effects like screen shaking. In *Sub Hunt*, shaking means the submarine has been hit by shells or depth charges. Loughry even implemented a SHAKETABLE in the code so that as more hits accumulate the shaking intensifies by manipulating the delay registers more drastically.
58. With the help of Kyle Davis, Zbiciak precisely estimated the CPU cycles per frame for Intellivision, including the number of CPU cycles available during vertical retrace, as "3780–3790" (Joe Zbiciak, "Intellivision"). So why was the number 2460 in the *Space Hawk* code? This is because the CPU also needs part of the 3780–3790 cycles to do other work before the next frame, like updating moving objects.
59. This is not an absolute constraint. Loughry's *The Dreadnaught Factor* implements smooth scrolling in two directions simultaneously. Without seeing the code, we do not know if this occurs during one or multiple vertical retrace periods.
60. Steve Bloom, *Video Invaders: Everything You Want to Know about Video Games Plus How to Beat Them!* (New York: Arco Publishing, Inc. 1982), 217.
61. Mia Consalvo, Abe Stein, and Konstantin Mitgutsch, "Sports Videogames: Mapping the Field," in *Sports Videogames*, ed. Mia Consalvo, Konstantin Mitgutsch, and Abe Stein, (New York: Routledge, 2013), 1.
62. Consalvo, Stein, and Mitgutsch, "Sports," 2; Ian Bogost, "What Are Sports Videogames?", in *Sports Videogames*, ed. Mia Consalvo, Konstantin Mitgutsch, and Abe Stein (New York: Routledge, 2013), 50.
63. Sports were a staple of mechanical coin-op games long before videogames, dating back to 1925's *Full Team Football* and beyond (Andrew Williams, *History of Digital Games: Developments in Art, Design and Interaction* (Boca Raton, FL: CRC Press, 2017), 10). A space-centric history elides this history and how "from its earliest incarnations, mass-market video gaming has simulated popular sports" (Thomas P. Oates and Robert Brookey, "Introduction," in *Playing to Win: Sports, Video Games, and the Culture of Play*, ed. Thomas P. Oates and Robert Brookey (Bloomington: Indiana University Press, 2015), 2; see Garry Crawford, "Is it in the Game? Reconsidering Play Spaces, Game Definitions, Theming, and Sports Videogames," *Games and Culture* 10, no. 6 (2015): 571–592).
64. Chris Crawford, *The Art of Computer Game Design* (Berkeley, CA: Osborne/McGraw-Hill, 1984), 27.

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65. For discussions of Intellivision and sports videogames, see Abe Stein, "Playing the Game on Television," in *Sports Videogames*, ed. Mia Consalvo, Konstantin Mitgutsch, and Abe Stein (New York: Routledge, 2013), 115–137; Michael Newman, "The Name of the Game Is Jocktronics: Sport and Masculinity in Early Video Games," in *Playing to Win: Sports, Video Games, and the Culture of Play*, ed. Thomas P. Oates and Robert Brookey (Bloomington: Indiana University Press, 2015): 23–44; Bogost, "What."
66. Jeff D. Montgomery, "Electronic Games: Technology Drives Market Explosion," in *Gametronics: The Electronic Game Designer's Conference* (Great Neck, NY: Electronic Engineering Times, 1977), 113.
67. Bloom, *Video*, 217.
68. "Mattel's Video Game," *WTD* 18, no. 20 (May 15, 1978): 10.
69. Chandler, in *Magnavox*, 676.
70. Heather Edison (later Brendel), "Basketball II video tape" [memorandum to Kevin Miller], February 4, 1982, HBA; Kevin Miller, Memorandum to Susan Bowles, March 2, 1982, HBA.
71. Stein, "Playing," 121.
72. Newman, "The Name," 37.
73. Oates and Brookey, "Introduction," 15.
74. Bloom, *Video*, 217.
75. Perry and Wallich, "Design," 48.
76. Crawford, *The Art*, 27.
77. Richard Rouse III, *Game Design: Theory and Practice, 2nd Edition* (Plano, TX: Wordware Publishing, 2005), 126. In this book, game industry heavyweights like Chris Crawford, Jordan Mechner, Sid Meier, and Will Wright address this debate.
78. Henri Bergson, *Creative Evolution* (London: Henry Holt and Company, 1911), 139.
79. Perry and Wallich, "Design," 48.
80. This reflects that "both remote controls and game controllers demonstrate . . . how deeply physical one's interaction with the television can be" (Sheila C. Murphy, *How Television Invented New Media* (New Brunswick, NJ: Rutgers University Press, 2011)), 109.
81. The upper buttons are connected, so there are in effect three action buttons.
82. Some contemporaneous systems like the Bally Astrocade and RCA's Studio II console used keypad interfaces built into the console. ColecoVision not only played off the "Intellivision" name but used a hand controller design clearly based on Intellivision.
83. Chandler received sole credit on its patent (David Chandler, Switch Apparatus, US 4246452, United States Patent and Trademark Office, January 20, 1981).
84. *Oxford English Dictionary*, s.v. "overlay, n.," July 2023, https://doi.org/10.1093/OED/6102788705.
85. Keith Robinson, "Background on the Intellivision Overlays" (undated), BSR.
86. John Sohl, "My Objection to Intellivision" [memorandum], November 3, 1980, BSR.
87. Steve Kenyon, "Intellivision Update," *Vidiot* (September 1982), 38.
88. See Cory Schwartz, "Intellivision II Hand Controller Appeal Test [MRD No. IN3182]," November 22, 1982, Cory Schwartz archive (CSA); Audrey Leeks, "1982 Intellivision and Atari Owner Satisfaction Study [MRD No. IN1182]," January 6, 1982, CSA.

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89. Rik Morgan, "Mattel's Missile Attack," *Handheld Games Museum*, accessed August 11, 2023, https://www.handheldmuseum.com/Mattel/MissileAttack.htm.
90. David James, "Battlestar Galactica: A Video Game Concept," June 1978, David James archive.
91. James, "Battlestar."
92. Bob Del Principe, email to authors, November 19, 2022.
93. This differs from the "conceptual maps" employed in some videogames, which simply "orient a player or indicate important events occurring in off-screen space" (Mark J. P. Wolf, "Inventing Space: Toward a Taxonomy of On- and Off-Screen Space in Video Games," *Film Quarterly* 51, no. 1 (Autumn 1997), 21.
94. *Star Raiders* was ported to the Atari VCS in 1982. Atari had its own Keyboard Controllers, recalling Intellivision's controllers, which were packaged with *Star Raiders*.
95. *Star Raiders* was influenced by Mike Mayfield's popular 1971 text-based *Star Trek* game, which included a sector grid (Tony Smith, "Star Trek: The Original Computer Game," *The Register*, May 3, 2013, https://www.theregister.com/2013/05/03/antique_code_show_star_trek/).
96. Tekla S. Perry and Paul Wallich, "Design Case History: The Atari Video Computer System," *IEEE Spectrum* 20, no. 3 (March 1983), 48.
97. Rouse, *Game*, 62.

Chapter 3

1. decle, "Intellivision Keyboard Component Pics," *AtariAge*, November 10, 2020, https://atariage.com/forums/topic/272846-intellivision-keyboard-component-pics/page/5/?tab=comments#comment-4674158.
2. decle, "Intelli-talk BBS Demonstration and Explanation," *YouTube*, April 11, 2021, https://www.youtube.com/watch?v=wtDyWVG1QYw&t=257s.
3. Jeff Rochlis, "Dear Ed" [memorandum to Edgar Sack], October 27, 1978, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00001.pdf.
4. See Michael Z. Newman, *Atari Age: The Emergence of Video Games in America* (Cambridge, MA: MIT Press, 2017), chapter 4.
5. Roberto Dillon, *Ready: A Commodore 64 Retrospective* (Singapore: Springer-Verlag, 2015), 6.
6. Tom Zito, "Playing a Calculated Game," *The Washington Post* (October 20, 1977), https://www.washingtonpost.com/archive/lifestyle/1977/10/20/playing-a-calculated-game/37e7d080-087a-4811-84e9-8d40647e3d5c/.
7. "Electronic Scanner," *Electronic Servicing* 26, no. 8 (August 1976), 4. The console was later renamed the Fairchild Channel F.
8. Gerald M. Walker, "Coming: Programmable Video Games," *Electronics* 49, no. 14 (July 8, 1976): 67–68; "Games—New CES Star," *Weekly Television Digest with Consumer Electronics* (*WTD*) 16, no. 25 (June 21, 1976): 13.
9. "Games/Computers at CES," *WTD* 18, no. 2 (January 9, 1978): 9.
10. Frost & Sullivan, *Home and Coin Operated Electronic Games* [Report #650] (New York: Frost and Sullivan, Inc., 1979), 61–62.
11. "Computer Games," *WTD* 18, no. 49 (December 4, 1978): 11.
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programmable game all have features which make them act like a basic home computer" (Frost & Sullivan, *Home*, 61–62).

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60. Rolfe, "Your."
61. "Software."
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Chapter 4

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Chapter 5

1. Morgan Romine, "Fractured Imaginaries: An Ethnography of Game Design" (PhD diss., University of California, Irvine, 2016), 54; see, inter alia, Casey O'Donnell, *Developer's Dilemma: The Secret World of Videogame Creators* (Cambridge, MA: MIT Press, 2014); Thomas M. Malaby, *Making Virtual Worlds: Linden Lab and Second Life* (Ithaca, NY: Cornell University Press, 2009); Nick Seaver, *Computing Taste: Algorithms and the Makers of Music Recommendation* (Chicago: University of Chicago Press, 2022).
2. Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39," *Social Studies of Science* 19, no. 3 (1989): 381.
3. David Rolfe, email to authors, May 17, 2020.
4. Nick Montfort and Ian Bogost, *Racing the Beam: The Atari Video Computer System* (Cambridge, MA: MIT Press, 2009), 28.
5. David Rolfe, email to authors, May 14, 2020.
6. There were exceptions such as scrolling, discussed in chapter 2. Newstadt also explained that programmers "wrote little programs" to test hardware timing—seeing how much processing could be done before an error occurred.
7. The EXEC code is distributed largely between two ROM chips, the RO-3-9502 and RO-3-9504, both made by GI. A small amount of space within Intellivision's GROM chip, the RO-3-9503, is stolen to store EXEC code as well. Intellivision II (chapter 8) consolidated the EXEC onto one chip.
8. Star and Griesemer, "Institutional," 393.
9. Graeme Mason, "Television with Intelligence," *Retro Gamer* 127 (2014), 56; Scott Stilphen, "DP Interviews David Rolfe," *DP Press*, accessed August 13, 2023, https://www.digitpress.com/library/interviews/interview_david_rolfe.html.

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10. Jimmy Maher, *The Future Was Here: The Commodore Amiga* (Cambridge, MA: MIT Press, 2012), 147.
11. David Rolfe, "Your Friend, The EXEC" (Mattel, Inc., 1978; Edition 2.0, 22 June 22, 1981), Blue Sky Rangers archive (BSR), 3-1.
12. Rolfe, "Your," 3-2.
13. Blue Sky Rangers, "Intellivision: Programmer Interviews," January 10, 2007, https://www.youtube.com/watch?v=bewzUlJEjcA.
14. Scott Stilphen, "Hal Finney Interview," *Atari Compendium*, 2006, https://www.ataricompendium.com/archives/interviews/hal_finney/interview_hal_finney.html.
15. Rolfe, "Your," 4–2.
16. Rolfe, "Your," 3–2.
17. Rolfe, "Your," 3–2.
18. Cliff Kuang with Robert Fabricant, *User Friendly: How the Hidden Rules of Design Are Changing the Way We Live, Work, and Play* (New York: Farrar, Straus and Giroux, 2019), 7.
19. Rolfe, "Your," 3–2.
20. Don Daglow and Mike Minkoff, "Original Game Design" [memorandum 0883–08 to Applications Software], August 16, 1983, BSR. Mattel Electronics eventually developed titles for the Atari VCS (chapter 12).
21. David Rolfe, "A Trivial Intellivision Game," David Rolfe archive.
22. Rolfe, "A Trivial"; David Rolfe, email to authors, August 24, 2020.
23. David Rolfe, email to authors, November 13, 2019.
24. John Sohl, "Killer (Trivia II)—Demonstration Program," May 26, 1981, BSR; John Sohl, email to authors, November 25, 2019. This program was also known as Trivia II.
25. In fact, programmers would encounter APh's MX Crossassembler version of the CP1610 assembly language. APh had written assemblers for a wide range of microprocessors in order to generalize and standardize writing programs for multiple microprocessors.
26. "GI & Honeywell Announce Joint Venture," *Microcomputer Digest* 1, no. 10 (April 1975): 4.
27. *Series 1600 Microprocessor System* [manual] (Hicksville, NY: General Instrument Corporation, 1975).
28. In contrast, Atari programmers had to push most computation through one of the 6502's six registers—specifically, the 8-bit accumulator that handles math processing.
29. Bob Newstadt, email to authors, October 28, 2020.
30. Rolfe, "Your," 1-2.
31. Jeff Stein, email to authors, September 21, 2020.
32. The CP1610 instruction set included the opcode "Set Double Byte Data" (SDBD), allowing the CPU to read two consecutive memory locations and combine them into a 16-bit word. This was a "wonderful kludge," as Rolfe called it (Rolfe, "Your," 1-9).
33. John Sohl, email to authors, October 8, 2020.
34. *Series*, 3.3.1. The instruction set also included numerous operations and commands that used only one register, such as loading or storing values in external memory locations.

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35. Rolfe, "Your," 3-2.
36. David Rolfe, email to authors, May 12, 2020.
37. In fact, it takes four interrupts to update all the animations of moving objects.
38. Rolfe, "Your," 3-1.
39. Rolfe, "Your," F-1.
40. "Outline for the Exciting Revised 'Your Friend, the EXEC'" [memorandum], undated. BSR; David Stifel, "Seminar for Thursday, July 21" [memorandum 0783-13 to All Intellivision Programmers], July 18, 1983, BSR.
41. "Orientation Seminars" (likely Keith Robinson), undated typewritten document, BSR; Don Daglow, "Programming Seminars" [memorandum to All Intellivision Programmers], February 9, 1982, BSR.
42. Dave Warhol, "Seminars for Wednesday, Jan. 26" [memorandum to All Intellivision Programmers], January 24, 1983, BSR.
43. Stefan Werning, *Making Games: The Politics and Poetics of Game Creation Tools* (Cambridge, MA: MIT Press, 2021), 27.
44. Analogous tools were developed for ColecoVision and even the Atari VCS, using a keypad plugged into the right controller jack (Eric Del Sesto, "Colecovision Mrcolor Users Manual," November 21, 1983, BSR; "Graphic Development System Operation," no author, April 11, 1983, BSR).
45. decle, "Intellivision Development, Back in the Day," *AtariAge*, June 12, 2020, https://forums.atariage.com/topic/259003-intellivision-development-back-in-the-day/.
46. Tom Loughry, email to authors, August 20, 2020. The PECO name was chosen by David Rolfe to echo TECO (Text Editor and Corrector), a text editor developed for DEC computers in the 1960s and used at APh (David Rolfe, email to authors, August 24, 2020).
47. decle, "Intellivision," 19.
48. Eric Wels, "Mr. Color, A Graphics Development System," 1982, BSR, 3.
49. Urbaniec, "Seminars for Wednesday, September 1." See decle, "Intellivision Development," 20; Tomlinson, "Dr."; Min and Taylor.
50. Wels, "Mr. Color," 13.
51. For instance, Daniel Bass and Karl Morris, "So You Think You're Out of Colors" [memorandum 0583–33 to Intellivision programmers and graphic designers], May 25, 1983, BSR.
52. Andy Sells and Daniel Bass, "Mr. Sound" [memorandum to All Intellivision Programmers], March 23, 1983, BSR; Andy Sells and Daniel Bass, "Mr. Sound, A Real-time Sound Development System for the Intellivision," March 1983, National Videogame Museum archive.
53. Andy Sells, "Intellivision Sound Effects/Music" [memorandum to Tim Scanlan and Sam Zahlan], March 25, 1983, BSR.

Chapter 6

1. Aphra Kerr, *The Business and Culture of Digital Games: Gamework/Gameplay* (London: Sage Publications, 2006), 91.
2. Olli Sotamaa and Jan Švelch, "Introduction: Why Game Production Matters?" in *Game Production Studies*, ed. Olli Sotamaa and Jan Švelch (Amsterdam: Amsterdam University Press, 2021), 8.

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3. Raiford Guins, *Atari Design: Impressions on Coin-Operated Video Game Machines* (London: Bloomsbury Visual Arts, 2020), 11, 16.
4. Richard Chang, "Resume of Richard S. Chang" (October 17, 1989), Winnie Chang archive.
5. Gabriel Baum, "Intellivision Programming Group" [memorandum], November 17, 1981, Blue Sky Rangers archive (BSR); Richard Chang, "Design and Development," December 18, 1981, BSR.
6. Teresa Young, "Green Sheets & Design Group Number" [memorandum to Rossi Stobbs], April 14, 1982, BSR; Teresa Young, "Office Procedures" [memorandum to All Intellivision Personnel], March 29, 1982, BSR.
7. Gabriel Baum, email to authors, January 10, 2020.
8. In February 1982 Chang proposed assigning a game to the programmer Eric Wels, but the director Don Daglow (who reported to Baum) complained, "I cannot have this kind of inappropriate interference from outside persons, no matter what their title or position may be" (Don Daglow, "See Below" [memorandum to Gabriel Baum], March 1, 1982, BSR).
9. "Cartridge Schedules 1982 [3 May]," Heather Brendel archive.
10. "The Creative Idea" [Human Resources brochure], Mattel Electronics (1982), BSR.
11. "Let All Your Capabilities Come into Play" (advertisement, Mattel Electronics), *Los Angeles Times*, April 20, 1980.
12. Once hired, programmers received a package of benefits and an annual salary around $92,000 in 2023 dollars.
13. decle, "Intellivision Development, Back in the Day," *AtariAge*, June 12, 2020, 21, https://forums.atariage.com/topic/259003-intellivision-development-back-in-the-day/. The code was likely from the EXEC or a videogame coded by Minkoff, like *PBA Bowling* or *Snafu*.
14. "The Creative."
15. Tom Boellstorff, *Coming of Age in Second Life: An Anthropologist Explores the Virtually Human, Second Edition with a New Preface* (Princeton, NJ: Princeton University Press, 2015). While a culture of work and play can be a source of creativity and fulfillment, playbor has also been pivotal to forms of labor inequality, precarity, and exploitation (see Nick Dyer-Witheford and Greig de Peuter, "A Playful Multitude? Mobilising and Counter-Mobilising Immaterial Game Labour," *Fiberculture* 5 (January 2005), https://doaj.org/article/a72d91f6519b4c7cad1a53e8b70aa054; Ergin Bulut, *A Precarious Game: The Illusion of Dream Jobs in the Video Game Industry* (Ithaca: ILR Press, 2020)).
16. Keith Robinson, "Women at Large" [handwritten document with images from the Golden Girls studio], 1982, BSR.
17. Robinson, "Women."
18. Aaron Trammell, *Repairing Play: A Black Phenomenology* (Cambridge, MA: MIT Press, 2023). See Braxton Soderman. *Against Flow: Video Games and the Flowing Subject* (Cambridge, MA: MIT Press, 2021).
19. Bill Gillis, email to authors, March 22, 2021. See Zach Whalen, "Channel F for Forgotten: the Fairchild Video Entertainment System," in *Before the Crash: Early Video Game History*, ed. Mark J. P. Wolf (Detroit, MI: Wayne State University Press, 2012): 60–80.
20. Bill Gillis, email to authors, March 22, 2021.
21. Bill Gillis, email to authors, April 22, 2021.

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22. Bill Gillis, email to authors, March 22, 2021.
23. Don Daglow, "Over the River and through the Woods: The Changing Role of Computer Game Designers," *Computer Gaming World* 50 (August 1988), 18.
24. Nick Seaver, "What Should an Anthropology of Algorithms Do?" *Cultural Anthropology* 33, no. 3 (2018), 376, https://doi.org/10.14506/ca33.3.04.
25. Baum, "Intellivision."
26. Baum, "Intellivision."
27. Don Daglow, "Position Description" [memorandum to Gabriel Baum and Mike Minkoff], August 27, 1982, BSR. Baum recalled Applications Software as having around 220 staff at its peak.
28. By 1982, as the Applications Software group grew, three managers were added with smaller staff and more specific missions: Rick Timmins (International Software Development), Joey Silvian (Creative Media, which included sound for Intellivoice cartridges), and Mona Theiss (Educational Products).
29. Gabriel Baum, "Procedural Changes" [memorandum to All Intellivision Personnel], April 1, 1982, BSR.
30. Keith Robinson, "Annotations to *TV Guide*'s article (June 19, 1982) about The Blue Sky Rangers," 1985, BSR; Michelle Mock, "Lunch Time Dungeons & Dragons Games" [memorandum to All Applications Software], June 23, 1982, BSR; Don Daglow, "Fantasy Role-Playing Game Meeting" [memorandum to all Intellivision programmers], February 15, 1982, BSR.
31. Paul Nurminen and Rick Reynolds, "Episode 19: *Tron Maze-A-Tron*," *The Intellivisionaries Podcast*, June 29, 2015, http://intellivisionaries.com/episode-19-tron-maze-a-tron/.
32. Keith Robinson, "The Intellivision Story: From the Intellivision Lives! CD-ROM," unpublished notes (likely 1998), BSR.
33. Brooke Erin Duffy, "The Romance of Work: Gender and Aspirational Labour in the Digital Culture Industries," *International Journal of Cultural Studies* 19, no. 4 (2016): 441–457.
34. Robinson, "The Intellivision Story."
35. Eric Del Sesto, "Timecards," Eric Del Sesto archive.
36. Gabriel Baum, "Master Components" [memorandum to Stav Prodromou], November 25, 1981, BSR.
37. David Stifel, "Linker Memo" [memorandum to all Intellivision programmers], November 10, 1982, BSR.
38. Mike Winans, "Documentation Library" [memorandum to All Intellivision Programmers], March 18, 1982, BSR; Don Daglow, "How to Keep Moving Objects from Crashing into Background Unless You Want Them To," September 1, 1981, BSR.
39. Dave Warhol, "Seminars for Wednesday, Jan. 12" [memorandum to All Intellivision Programmers]. January 5, 1982. BSR.
40. Warhol, "Seminars for Wednesday."
41. "Orientation Seminars" (likely Keith Robinson), undated typewritten document, BSR; Dave Warhol, "Seminars for the Week of May 9th" [memorandum 0583–09 to All Intellivision Programmers], May 6, 1983, BSR.
42. Gabriel Baum, "See Below" [Memorandum to All Intellivision Programmers], June 1, 1982, BSR; Don Daglow, "Projects" [memorandum to Russ Haft, Keith Robinson, Mark Urbaniec, and Mike Winans], October 5, 1982, BSR.

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43. Russ Haft, "Project Progress" [memorandum to "The Duke" (Gabriel Baum)], October 7, 1982, BSR.
44. Gabriel Baum, "Software Review" [memorandum to Josh Denham, Stav Prodromou, Peter Pirner, and Hugh Barnes], September 3, 1982, BSR.
45. Gabriel Baum, "Product Review" [memorandum to All Intellivision Programmers], April 26, 1982, BSR.
46. Daglow, "Over," 42.
47. Richard Chang, "Blue Sky Session" [memorandum to All D&D Dept.], July 6, 1981, BSR.
48. Tom Loughry, "Preliminary Cartridge Descriptions," June 30, 1981, Tom Loughry archive (TLA).
49. Gabriel Baum, "First Intellivision Brainstorming Session" [memorandum to Mike Minkoff, Don Daglow, et al.], January 25, 1982, BSR; Mona Theiss, "Brainstorming Notes" [memorandum to All Participants Involved with the Educational Brainstorming Session], May 31, 1983, National Videogame Museum archive (NVM).
50. Connie Goldman, "Heaven Sent," undated, BSR.
51. Dave Warhol, "Project Assignment" [memorandum to Don Daglow], June 17, 1982, BSR.
52. Ray Wagner, "Rocky Horror Show" [memorandum to Josh Denham], November 23, 1981, NVM; Robert Anderson, "Creative Opportunity?" [memorandum to Bill Gillis, Pete Pirner, and Stav Prodromou], July 26, 1982, NVM.
53. Joan L. Herman, "Research and Development in the Toy Industry," *Performance Improvement* 21, no. 4 (1982): 36–38, doi.org/10.1002/pfi.4170210417, 36.
54. Chang, "Blue." Other examples of discussing videogame ideas with marketing include Don Daglow, "Game Ideas" [memorandum 0483–15 to Daglow Group Members], April 25, 1983, BSR.
55. Richard Rouse III, *Game Design: Theory and Practice, 2nd Edition* (Plano, TX: Woodware Publishing, 2005), 67.
56. Keith Robinson, "B-17 Bomber," *Blue Sky Rangers*, accessed August 14, 2023, http://history.blueskyrangers.com/mattelelectronics/games/b17bomber.html.
57. Brad Geagley, "New Ideas Meeting, March 15, 1983" [memorandum to Gabriel Baum, Don Daglow, Joey Silvian, Mike Minkoff, and Russ Haft], March 17, 1983, BSR.
58. Russ Haft, "Software Sound Effects/Music Support" [memorandum to Intellivision/Lucky Application Software Staff], December 22, 1982, BSR.
59. Don Daglow, "Draft List—Cartridges to Graphic Designers, Sound Specialists and Educational Product Specialists" [memorandum], May 9, 1983, BSR; Game Development Memo (no author or date), BSR.
60. Geagley, "Dante's."
61. Jeffrey Greene and Laura Palmer, "It's All in the Game: Technical Communication's Role in Game Documentation," *Intercom* (December 2011), 7, https://www.researchgate.net/profile/Laura-Palmer-8/publication/277776279_It's_All_in_the_Game_Technical_Communication's_Role_in_Game_Documentation/links/5573814308aeacff1ffca3a4/Its-All-in-the-Game-Technical-Communications-Role-in-Game-Documentation.pdf.
62. Tom Loughry, "*Boxing* Gameplay and Instructions," November 4, 1980, TLA; Tom Loughry, "Intellivision Boxing Changes," February 20, 1981, TLA.

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63. William Fisher, *Code to Space Hawks!* [*Space Hawk*], 1981, NVM, 88. In one case, an instruction manual determined videogame design. Significant problems with the code for *NFL Football* were discovered after it was already advertised as an upcoming release and its manual had been finalized. At APh, Ken Smith and Kevin Miller were asked to help but could not successfully debug the code. As a result, Smith recalled that they "just took the description of the game as it was in the instructions and the playbooks and said, 'We're just going to build this from scratch'" (K. Smith, in Paul Nurminen and Rick Reynolds, "Episode 8: *Sea Battle*," *The Intellivisionaries Podcast*, April 27, 2014, http://intellivisionaries.com/episode-8-sea-battle/).
64. Karl Morris, Bob Newstadt, Karen Nugent, and Dave Warhol, "Game Design" [memorandum 0783–15 to All Applications Software Staff], July 22, 1983, BSR.
65. Olli Sotamaa, "Game Developers Playing Games: Instrumental Play, Game Talk, and Preserving the Joy of Play," in *Game Production Studies*, ed. Olli Sotamaa and Jan Švelch (Amsterdam: Amsterdam University Press, 2021), 104.
66. Sotamaa, "Game."

Chapter 7

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2. Ian Bogost, *Play Anything: The Pleasure of Limits, the Uses of Boredom, and the Secret of Games* (New York: Basic Books, 2016), 146; see Douglas Khan, "Between a Bach and a Bard Place: Productive Constraint in Early Computer Arts," in *MediaArtHistories*, ed. Oliver Grau (Cambridge, MA: MIT Press, 2007): 423–452; Don Norman, *The Design of Everyday Things, Revised and Expanded Edition* (New York: Basic Books, 2013); Matthias Vogel, *Media of Reason: A Theory of Rationality*, translated by Darrell Arnold (New York: Columbia University Press, 2012).
3. Bogost, *Play*, 157. Elsewhere, Montfort and Bogost noted that cultural, economic, and political constraints condition creativity (Nick Montfort and Ian Bogost, *Racing the Beam: The Atari Video Computer System* (Cambridge, MA: MIT Press, 2009), 127).
4. Nathan Altice, *I AM ERROR: The Nintendo Family Computer/Entertainment System Platform* (Cambridge, MA: MIT Press, 2015), 193.
5. James J. Gibson, *The Ecological Approach to Visual Perception* (New York: Taylor & Francis, 1986), 128; see Ian Hutchby, "Technologies, Texts, and Affordances," *Sociology* 35, no. 2 (2001): 441–456, https://doi.org/10.1177/S0038038501000219.
6. Bogost, *Play*, 164.
7. Hector Postigo, "The Socio-Technical Architecture of Digital Labor: Converting Play into YouTube Money," *New Media and Society* 18, no. 2 (2016), 336, https://doi.org/10.1177/1461444814541527.
8. Jeffrey S. Juris, "Reflections on #Occupy Everywhere: Social Media, Public Space, and Emerging Logics of Aggregation," *American Ethnologist* 39, no. 2 (2012): 259–279, https://doi.org/10.1111/j.1548-1425.2012.01362.x; Postigo, "The Socio-Technical"; Peter Nagy and Gina Neff, "Imagined Affordance: Reconstructing a Keyword for Communication Theory," *Social Media + Society* 1, no. 2 (2015): 1–9, https://doi.org/10.1177/2056305115603385.

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9. Clement Greenberg, *Clement Greenberg: The Collected Essays and Criticism, Vol. 4*, ed. John O'Brian (Chicago: University of Chicago Press, 1993), 86.
10. Mary Ann Doane, "The Indexical and the Concept of Medium Specificity," *differences: a Journal of Feminist Cultural Studies* 18, no. 1 (May 2007), 130.
11. Roland Betancourt, "Genre as Medium on YouTube: The Work of Grace Helbig," *Journal of Popular Culture* 49, no. 1 (2016): 212–213; Nathan Altice, "Greenberg's Arcade: Videogames and the Medium Specificity Debate," *AlticePortfolio*, 2009, people.vcu.edu/~alticend/docs/greenbergarcade.html.
12. Rosalind E. Krauss, *Under Blue Cup* (Cambridge, MA: MIT Press, 2011), 7. "Affordance zone" shares an affinity with Bogost's use of the mathematical notion of "possibility space" to describe a space of circumscribed but productive possibility (Bogost, *Play*, 165).
13. The STIC's collision detection caused many problems, and thus David Rolfe included software collision detection in the EXEC to remedy some of these issues, adding to the possibilities in the affordance zone.
14. Montfort and Bogost, *Racing*, 72–75.
15. Keith Robinson, "Master Component," *Blue Sky Rangers*, accessed August 14, 2023, http://history.blueskyrangers.com/hardware/2609.html. Multiplexing is used in a few third-party Intellivision games. For example, in Parker Brothers's *Popeye*, many flickering hearts float down the screen, perhaps an acceptable effect given they are understood to be "beating."
16. Some demo cartridges and *Hover Force* (released by INTV in 1986) were 24KD.
17. Gabriel Baum, "See Below" (Memorandum to Stav Prodromou), July 18, 1982, BSR.
18. For example, Mattel Electronics held a seminar called "Decle Savers," and a planned 1981 revision to Intellivision's programming manual included "decle-saving hints" based on programmer experience (Mark Urbaniec, "Seminars for Wednesday, September 22, 1982," September 21, 1982, BSR; David Stifel and Mike Breen, "New Exec Chapter 1, Draft 1.1.," October 26, 1981, BSR).
19. Don Daglow, "*Treasures of Tarmin* title screen" [memorandum to Margaret Yochem], December 16, 1982, BSR.
20. Tom Loughry, email to authors, December 25, 2019.
21. Marvin A. Kempner, *Can't Wait till Monday Morning: Syndication in Broadcasting* (New York: Rivercross Publishing, 1998), 217. Charles Erickson, "When the Future of TV Was a Youngster Yelling 'Pow!'" *New York Times*, June 9, 2002.
22. For example, a memo suggested adaptations for *Astrosmash*, *Horse Racing*, *Frog Bog*, and *Space Hawk*. For *Horse Racing*, the recommendation was "greatly simplify—we need only the race itself and a few embellishments." For *Frog Bog*, "the telephone player's 'Pow!' should cause the Frog to jump at an insect." For *Space Hawk*, "the only control executed between the telephone player is the firing of the Hunter's Ray Gun by saying 'Pow!'" (Paul Nagel, "Adaptions [sic] for Intellivision Powww!" [memorandum to Marv Kempner], January 5, 1983, BSR).
23. Duncan Harrower, "AY-3-8915 Color Processor: Customer Procurement Specifications," April 29, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00012.pdf.
24. Stephen Maine, email to authors, December 12, 2022.
25. Stephen Maine, email to authors, December 12, 2022.
26. James Ruddy, *Graphical Harmony* (Polaroid Corporation, 1982).

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27. Daniel Bass and Karl Morris, "So You Think You're Out of Colors" [memorandum 0583–33 to Intellivision programmers and graphic designers], May 25, 1983, BSR.
28. Bass and Morris, "So."
29. Keith Robinson, "Fear and Loathing at The Consumer Electronics Show" (draft of Chapter 7, "Crash of the Blue Sky Rangers"), no date, BSR.
30. Donna Leccese, "Winter CES Draws a Record 78,126," *Playthings* 81, no. 4 (April 1983): 44.
31. Judy Johnson, "Consumer Electronics Show, January 1983" [memorandum]. October 21, 1982, BSR; "Pricing and Agenda" [regarding January 1982 CES], undated document, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF1028 2011_00000.pdf; Frank O'Connell, email to authors, November 25, 2019.
32. For example, Gabriel Baum, "Meeting of 28th December" [memorandum to Ray Feeney], December 29, 1981, BSR; Gabriel Baum, "Voice Cartridge B-17 at CES" [memorandum to Stav Prodromou, Richard Baumbusch, and Chuck Rudd], December 23, 1981, BSR.
33. Richard Chang, "Preliminary Design Project Priorities: Line Year 1982," no date, BSR.
34. Daglow, "President's."
35. Daglow, "President's."
36. Don Daglow, "December Final Code Releases" [memorandum to Joel Crain], December 13, 1982, BSR.
37. Intellivision's CP1610 processor had a jump operation requiring "three consecutive memory locations," thus 3 decles. J $-3 simply jumped back 3 memory addresses, causing the jump to loop. *Series 1600 Microprocessor System* [manual] (Hicksville, NY: General Instrument Corporation, 1975), 3.3.5.
38. "Sales of Licensed Goods Soar to $8.1 Billion; Toys Account for 30% of Total Royalties," *Playthings* 78, no. 3 (March 1980): 34.
39. Don Daglow, "New Game Ideas" [memorandum 0483–19 to Daglow Group Members], April 28, 1983, BSR.
40. Kathi Keeny, "Intellivision Licensors: Summary of Agreements," February 23, 1983, William Fisher archive.
41. Keeny, "Intellivision."
42. Keith Robinson, "Keith Robinson Proudly Presents Thin Ice" [memorandum], May 28, 1982, BSR.
43. Gabriel Baum, "Disco No. 1 (Data East Co.)" [memorandum to Pete Pirner], June 23, 1982, BSR.
44. Robinson, "Keith."
45. Tom Loughry, "Trench Game—Research Proposal," May 27, 1981, Tom Loughry archive (TLA); Tom Loughry, "Trench Game—Cartridge Proposal," May 28, 1981, TLA.
46. Don Daglow, "'*Tron*' Voice Cartridge Proposal" [memorandum to Gabriel Baum], August 24, 1981, National Videogame Museum archive (NVM).
47. Tom Loughry, "Trench Instructions," August 19, 1981, TLA.
48. Another failed film/television license involved David James's idea for a videogame based on the *Battlestar Galactica* television series (chapter 2).
49. Don Daglow, "Licensed Character List" [memorandum to Craig Spitzer], November 30, 1982, BSR; "In Other Activity," *Weekly Television Digest with Consumer*

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Electronics (*WTD*) 22, no. 41 (October 11, 1982): 12; "Game Notes," *WTD* 23, no. 1 (January 3, 1983): 14.

50. Gabriel Baum, "Hanna Barbera" [memorandum to Pete Pirner], July 9, 1982, BSR.
51. Pete Perner, in Baum, "Hanna."
52. "Ad Notes," *WTD* 23, no. 13 (March 28, 1983): 16.
53. William Fisher, *Code to Space Hawks!* [*Space Hawk*], 1981, NVM, 83.
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62. "Universe Figures Invade West Coast," *Playthings* 80, no. 10 (1982): 30–32.
63. Ray Kaestner, email to authors, November 4, 2019.
64. Rick Koenig, in Paul Nurminen and Rick Reynolds, "Episode 26: *Masters of the Universe: The Power of He-Man*," *The Intellivisionaries Podcast*, April 6, 2016, http://intellivisionaries.com/episode-26-masters-of-the-universe-the-power-of-he-man/.
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66. Keith Robinson, "*Masters of the Universe: The Power of He-Man*," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/mattelelectronics/games/masters.html.
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69. M. Chastain, "Consumer Inquiry Regarding Program Glitch on Mattel's Backgammon Cartridge" [memorandum to T. Longworth], October 5, 1981, BSR.
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71. Don Daglow, email to authors, September 21, 2019. These include later versions of *Armor Battle* (faster tank movement), *Auto Racing* (improved steering), and *PGA Golf* (par information added). See David Harley, "Mattel Intellivision FAQ," https://www.intellivision.us/faq.htm#_Toc140592042.

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Chapter 8

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4. Stav Prodromou, *MEL Transition Plan*, McKinsey & Company, April 5, 1982, Blue Sky Rangers archive (BSR), 5.
5. Donna Leccese, "Video Game Entries Excite CES Crowd," *Playthings* 80, no. 8 (August 1982): 43–44; "Sony's Quarter," *WTD* 22, no. 12 (March 22, 1982): 10. While not specified, these are likely US sales figures.
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8. Thomas C. Hayes, "Mattel Is Counting on Its Toys," *New York Times*, February 4, 1984.
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14. Don Daglow and Mike Minkoff, "Use of Other People's Terminals" [memorandum to All Applications Software Personnel], July 7, 1982, BSR.

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17. "Comprehensive Project Status Report," Applications Software Group, January 10, 1984, BSR; "Storyboards (Nice Ideas)," no author or date, Tim Scanlan archive. See Alessandro Pace, "Intellivision 'Lost' Games: Data Sheets on Unreleased Games," July 2009: 193; 198–199; 224–225; Keith Robinson, "Party Line," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/mattelelectronics/games/partyline.html.
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22. Thomas Lohff, "Fuzzball!!! The Game of Lint" [memorandum], March 3, 1983, NVM; Sandy Disner, "Greenpeace Game" [memorandum], undated, NVM; David James, "Intellivision Brainstorming Meeting of 5/20/81" [memorandum to Richard Chang], May 21, 1981, BSR.
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of Insolvency and Bankruptcy from an International Perspective, ed. Karl Gratzer and Dieter Stiefel (Huddinge, Sweden: Söderstörns Högskola, 2008), 185.

31. Hanson, "Intellivision."
32. Traci Glauser, "*Lock 'n' Chase* (Revised) Intellivision Reliability Test Report," August 31, 1982, BSR. While this version of *Lock 'n' Chase* was completed, it is unclear if it was sold, since ROMs for the revision have not been discovered.
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34. Fisher, "Games."
35. Spitzer, "What."
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38. Cy Schneider, *Children's Television: How It Works and Its Influence on Children* (Lincolnwood, IL: NTC Business Books, 1989), 31.
39. Mia Consalvo, *Cheating: Gaining Advantage in Videogames* (Cambridge, MA: MIT Press, 2007), 22.
40. "Astrosmash: The Big Money," *Vidiot* (September 1982): 41; Keith Robinson, "*Astrosmash*," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/mattelelectronics/games/astrosmash.html.
41. "Houston Hosts Astrosmash Shoot Off," *Electronic Games* 1, no. 12 (February 1983): 10.
42. Pace, "Intellivision," 145.
43. Robinson, "*Astrosmash*."
44. "Space Superbowl: Top Guns Score in Mattel's Astrosmash Shoot-Off," *Electronic Fun with Computers and Games* 1, no. 2 (December 1982): 41–42.
45. Tom Loughry similarly recalled that this contract was $1,000,000 up front and $0.65 royalties per cartridge shipped.
46. Gabriel Baum, Letter to Ray Feeney, January 25, 1982, BSR. Feeney, a Caltech graduate, was working at the time for Robert Abel & Associates, a company developing film technology who had hired APh for consulting work. By March 1982, APh internally renamed "Analemma" projects as "VCS projects" (Heather Edison (later Brendel), "Analemma Turned VCS" [memorandum to Sandra Shrader], March 16, 1982, Heather Brendel archive).
47. Gabriel Baum, "Meeting of 28th December" [memorandum to Ray Feeney], December 29, 1981, BSR.
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50. David Rolfe, email to authors, May 25, 2021.
51. "If You Think Our Advertising Is Competitive, Wait Until You See Our New Price" (advertisement), *Playthings* 81, no. 1 (January 1983).
52. Chris Barnett, "Mattel Rises. Again," *Los Angeles Magazine* (December 1985), 273.
53. Keith Robinson, "Intellivision II," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/hardware/intellivision2.html. Using the System Changer on the original Intellivision required sending it in for a modification.

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54. On October 21, 1982, Stav Prodromou stated Mattel Electronics was "just beginning production" of Intellivision II (Telex to Nobuyuki Idei, October 21, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10242011_00005.pdf.
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56. Cory Schwartz, "Intellivision II Hand Controller Appeal Test" [MRD No. IN3182], November 22, 1982, Cory Schwartz archive.

Chapter 9

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3. "SP0256 Narrator Speech Processor," Archer Technical Data (Catalog Number 276-1784), undated, BSR.
4. Gabriel Torres, "Inside the Magnavox Odyssey^2," *Hardware Secrets*, April 30, 2012, https://hardwaresecrets.com/inside-the-magnavox-odyssey2/; see Owen Linzmayer, "The Voice of Odyssey," *Creative Computing Video & Arcade Games* 1, no. 1 (Spring 1983): 60, https://www.atarimagazines.com/cva/v1n1/odyssey.php.
5. "Video Game/Computer Systems," *Creative Computing* 7, no. 3 (March 1981), 62.
6. Robert Anderson, "Intellivision—Voice Synthesis" [memorandum to Ray Wagner and Josh Denham], January 9, 1981, Paul Chandler archive (PCA). The system was never produced: Mego filed for bankruptcy in 1982.
7. David Chandler, "Outline [Voice Synthesis]," 1981, PCA.
8. Chandler, "Outline."
9. Robinson, "Intellivoice."
10. Randolph, "Intellivoice," 10.
11. Documentation explained that "a phoneme is acoustically different depending upon its position within a word. Each of these positional variants is an allophone of the same phoneme. An allophone, therefore, is the manifestation of a phoneme in true speech signal" ("SP0256A Design Objective Specification" (Document Control #0383–03), General Instrument, April 21, 1983, Stephen Maine archive, 8). Chandler also suggested an "allophone package" Intellivoice peripheral for generating speech from discrete speech units, like Radio Shack's SP0256-AL2 variant (Chandler, "Outline").
12. Chandler, "Outline."
13. Randolph, "Intellivoice"; Chandler, "Outline."
14. Chandler, "Outline," 12.
15. Chandler, "Outline," 12.
16. Keith Robinson, "Voice," undated document, BSR.
17. Robinson, "Voice."
18. Robinson, "Voice."
19. Robinson, "Voice."
20. "SP0256A."
21. "Space Shuttle Voice Analysis (Nutter—Mission Control)," June 16, 1983, BSR.
22. Robinson, "Voice."
23. Robinson, "Intellivoice."

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24. Robinson, "Voice."
25. Ron Carlson and Deidre Cimarusti, "Scheduling of Voice Cartridges" [memorandum], January 26, 1983, BSR.
26. "Space Shuttle Syntax Diagram," December 28, 1982, BSR.
27. Robinson, "Voice."
28. Carlson and Cimarusti, "Scheduling."
29. Silvian, in "New Ideas Meeting (Voice)," March 15, 1983, BSR.
30. Silvian, in "New"; Carlson and Cimarusti, "Scheduling"; see Keith Robinson, "Intellivoice Games," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/mattelelectronics/voicegames.html.
31. The others were Phil Austin (*B-17 Bomber*) and Peter Bergman (*Bomb Squad*) (Joe Zbiciak, email to authors, September 4, 2020).
32. Carlson and Cimarusti, "Scheduling."
33. Thom Randolph, email to authors, December 15, 2022.
34. Carlson and Cimarusti, "Scheduling."
35. Philip McLaughlin, email to authors, February 12, 2019.
36. Carlson and Cimarusti, "Scheduling."
37. Robinson, "Intellivoice."
38. Carlson and Cimarusti, "Scheduling."
39. "Questionnaire for Speech Identification Test," July 1983, BSR.
40. Sandy Disner, "Perceptual testing results for Space Shuttle" [memorandum to Keith Robinson and Stephen Roney], July 22, 1983, BSR.
41. While manuals never provided an exhaustive list of phrases spoken, they did provide examples and almost always listed the voice characters, recalling how manuals were also used to help turn bugs into features (chapter 7).
42. Deidre Cimarusti, "Space Shuttle Rework" [memorandum to Irene Pfannkuch], January 18, 1983, BSR.
43. International versions of *Space Spartans* were completed but never released, and other games were in various stages of development. No effort was made for *B-17 Bomber* due to its theme of bombing Europe (Robinson, "Intellivoice").
44. Franz Josef Darius, "German Space Spartans Audition Script" [telex no. 194 to Gabriel Baum], July 20, 1982. BSR.
45. Gabriel Baum, "Telex 194—Script Changes" [telex to Franz Josef Darius], July 26, 1982, BSR.
46. Darius, "German."
47. Carlson and Cimarusti, "Scheduling."
48. Robinson, "Voice."
49. Robinson, "Voice."
50. Margaret Kahn and Peter Gurst, "The Effects of Five Voice Characteristics on LPC Quality," *ICASSP '83. IEEE International Conference on Acoustics, Speech, and Signal Processing*, Boston, MA (1983), 532, https://doi.org/10.1109/ICASSP.1983.1172266. Some studies found that for very high frequency speech "LPC analysis can be totally ineffective" and recommended shorter sampling windows to "give crisper sounding synthesis" (David Wong, "On Understanding the Quality Problems of LPC Speech," *ICASSP '80. IEEE International Conference on Acoustics, Speech, and Signal Processing*, Denver, CO (1980), 726, https://doi.org/10.1109/ICASSP.1980.1170925). Intellivision's sound chip allowed the sampling window to be adjusted,

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thus shorter windows would lead to more data being stored for higher frequency voices.

51. The fact that women's voices were more difficult and memory-intensive to produce was not purely biological; it was also the result of social norms. As one review found, transgender women can increase base vowel frequency by an average 64 Hz (about seven semitones) through speech therapy (Clara Leyns, et al, "Effects of Speech Therapy for Transgender Women: A Systematic Review," *International Journal of Transgender Health* 22, vol. 4 (2021), 371, https://doi.org/10.1080/26895269.2021.1915224). Such shifts are not limited to individual effort. Greater gender equality has been correlated with "women's pitch becoming lower and thereby more similar to men's" (Barbara Krahé and Lida Papakonstantinou, "Speaking like a Man: Women's Pitch as a Cue for Gender Stereotyping," *Sex Roles* 82, vol. 1–2 (2020), 94, https://doi.org/10.1007/s11199-019-01041-z). For instance, a study of over 2,500 men and women in Germany found that by the 2010 the "mean speaking voice frequency of women was 6–7 semitones lower" than in the 1990s, "reducing the gap between women and men by half" (Krahé and Papakonstantinou, 94).
52. Keith Robinson, "Voice Used in Final Release of Tron 'Solar Sailer,'" October 5, 1982, BSR.
53. Gabriel Baum, telex to H. U. Lehmann, July 16, 1982, BSR.
54. See Liz W. Faber, *The Computer's Voice: From Star Trek to Siri* (Minneapolis: University of Minnesota Press, 2020).
55. Janice Hanson, "Voice Synthesis Research" [MRD No. IN1481], January 4, 1982, Cory Schwartz archive (CSA).
56. "Save $10 on New Intellivoice Module" (advertisement), *The Daily Oklahoman*, October 21, 1982: 19; "Discover Intellivoice" (advertisement), *St. Louis Post-Dispatch*, December 16, 1982: 30.
57. Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, CSA.
58. "Free Intellivoice Offer," *Intellivision Game Club News* 6 (Fall 1983): 12.
59. Don Daglow, "New Game Ideas" [memorandum 0483–19 to Daglow Group Members], April 28, 1983, BSR.
60. Larry Anderson, "Mattel Intellivision Frequently Asked Questions (FAQ)," June 27, 1995, BSR. The title was released in 1987 by INTV (see Aftercrash) as *Tower of Doom*, without voice.

Chapter 10

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3. Gary Moskovitz, email to authors, January 8, 2023.
4. Russell Sipe, "Computer Games in 1983: A Report," *Computer Gaming World* 3, no. 2 (1983), 11.
5. Keith Robinson, "Entertainment Computer System," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/hardware/ecs.html; John Sohl, "Results of the Blue Sky Session of July 7th, 1981," July 17, 1981, National Videogame Museum archive (NVM).

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6. "December 21, 1981 management meeting notes" [handwritten, no author listed], November 20, 1981–February 22, 1982, Heather Brendel archive.
7. J. Wallace Adair, Letter to Timothy Reames, August 4, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00014.pdf.
8. Gary Moskovitz, in Paul Nurminen and Rick Reynolds, "Episode 40: Marketing, Art & Christmas," *The Intellivisionaries Podcast*, December 16, 2020, http://intellivisionaries.com/episode-40-marketing-art-christmas/; Pete Pirner, "Performance Planning and Appraisal," December 3, 1982, Gary Moskovitz archive.
9. "Mattel Electronics Diagnostic Report," December 1981, 61, William Fisher archive.
10. The Keyboard Component did not have the BASIC programming language onboard but required consumers to purchase a BASIC cartridge.
11. David Chandler, "Intellivision History and Philosophy," 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00016.pdf.
12. Chandler, "Intellivision History."
13. Chandler, "Observations." Ironically, in April 1983 an article announced "Intellivision's brand new computer keyboard is at last ready for release," speaking of the ECS but using an image of the Keyboard Component ("Intellivision's Keyboard"). Perhaps the confusing switch from the Keyboard Component to the ECS was in Mattel Electronics' interest, since the ECS was intended to replace the Keyboard Component.
14. David Chandler, "Observations and Reflections," handwritten document on "The Inn at McCormack Ranch" letterhead, October 1982, Paul Chandler archive.
15. Since the ECS only added support for certain features and devices, this did not require a complete overhaul of the Master Component's original EXEC.
16. Management Memo vol. xvi, no. 12, November 10, 1982, Blue Sky Rangers archive (BSR).
17. "Mattel's Computer," *TV Digest* 22, no. 11 (November 1, 1982): 12; "Mattel Electronics Sparks Line with Aquarius and Intellivision," *Playthings* 81, no. 2 (February 1983): 118.
18. Kathy Kennedy, "Intellivision Entertainment Computer System Offers All the Right Connections" [news release], Mattel Electronics, 1983.
19. As discussed in chapter 1, Preliminary Design, founded in 1969, was located within Mattel Toys and was tasked with coming up with new product ideas. While Chang had left the group to become the director of Design and Development within Mattel Electronics, he remained in contact with many Preliminary Design staff.
20. Don Daglow, "Attached" [memorandum to Gary Moskovitz], November 29, 1982, BSR.
21. Phillippe D'Argent, "Lucky Software" [memorandum to Gabriel Baum, Rick Timmins, and Richard Tuthill], May 19, 1983, BSR.
22. Thom Randolph, email to authors, January 9, 2020.
23. Javad Hashtroudian, "Memorandum to Richard Tuthill," May 24, 1983, BSR.
24. Keith Robinson, "LUCKY Keyboard" [memorandum to Andy Sells], May 16, 1983, BSR.
25. "December 21."
26. Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, Craig Spitzer archive.
27. Sipe, "Computer," 10.
28. Kennedy, "Intellivision."

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29. Robinson, "Entertainment."
30. Don Daglow, "New Game Ideas" [memorandum 0483–19 to Daglow Group Members], April 28, 1983, BSR.
31. Gabriel Baum, "Lucky Educational Titles" [memorandum to Pete Pirner], August 4, 1982, BSR. The only non-ECS sports videogame not canceled was *World Championship Baseball* (Robinson, "*World Championship*").
32. Dave Warhol, "The Lucky Pioneers of the Software Support Group," November 16, 1982, BSR. As of January 1983, programmers still did not have access to the musical keyboard (Steve Ettinger, "Musical Enhancement" [memorandum to Gabriel Baum], January 18, 1983, BSR). Even by June many of these programmers still had no ECS hardware (Andy Sells, "Hardware Support of Applications Software Group" [memorandum to Don Daglow], June 17, 1983, BSR.).
33. Our thanks to Joe Zbiciak for discovering this comment.
34. Daniel Bass, Bill Goodrich, and Michelle Mock, "Intellivision Dungeons and Dragons Cassette" [memorandum to Don Daglow], May 5, 1982, NVM; Michelle Mock, "Lunch Time Dungeons & Dragons Games" [memorandum to All Applications Software], June 23, 1982, BSR; Jane Terjung and Daniel Bass, "Dungeons & Dragons Game Proposal," April 14, 1983, NVM.
35. Michelle Mock, "Demonade" [memorandum to Don Daglow], July 7, 1982, BSR.
36. Pamela Sosnowski, "Before 3D Printers, There Was Mattel's VAC-U-FORM," *Go Retro*, December 2016, https://www.goretro.com/2016/12/before-3d-printers-there-was-mattels.html.
37. Robinson, "LUCKY."
38. Richard Chang, et al. Electronic Organ Wherein Musical Sounds and a Tremolo Effect are Provided by Electro-Optical Apparatus, US 3647927, United States Patent and Trademark Office, March 7, 1972.
39. Brad Geagley, "Review of 1981's Projects" [memorandum to Gabriel Baum], August 11, 1981, BSR.
40. David Rolfe, "Your Friend, The EXEC" [YFTE] (Mattel, Inc., 1978; Edition 2.0, 22. June 22, 1981), BSR, 2–3.
41. Duncan Harrower, "AY-3-8915 Color Processor: Customer Procurement Specifications," April 29, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00012.pdf.
42. "Designing Sounds," no author (likely Hal Finney), June 26, 1979, BSR, 4.
43. "Designing," 9.
44. "Designing," 5.
45. "Designing," 15.
46. Karen Collins, *Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design* (Cambridge, MA: MIT Press, 2008), 12.
47. Karen Collins, "One-Bit Wonders: Video Game Sound before the Crash." In *Before the Crash: Early Video Game History*, ed. Mark J. P. Wolf (Detroit, MI: Wayne State University Press, 2012), 126.
48. "Designing," 4.
49. Keith Robinson, "*Melody Blaster*," *Blue Sky Rangers*, accessed August 16, 2023, http://history.blueskyrangers.com/mattelelectronics/games/melodyblaster.html.
50. DZ-Jay, "The Intv Ecs Club," *AtariAge*, June 27, 2013, https://atariage.com/forums/topic/213870-the-intv-ecs-club/?tab=comments#comment-2782455. Joe Zbiciak helped with Pujals's videogame.

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51. Stefan Werning, *Making Games: The Politics and Poetics of Game Creation Tools* (Cambridge, MA: MIT Press, 2021), 39.

Chapter 11

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2. Polskin, "Calling," 20.
3. "Ready, Set, PlayCable!," undated [likely 1982], Paul Hilt archive (PHA).
4. "Ready."
5. Richard Burton, "The Latest News from November 1980," *Retro Gamer* 127 (2014), 16; see "Shades of PlayCable . . . Or, Is Cable Getting Ready to (VOD) Play?," *Cablefax*, December 6, 2004, https://www.cablefax.com/archives/shades-of-playcableor-is-cable-getting-ready-to-vod-play. A similar service released in the early 1980s was The Games Network (Steve Stecklow, "Home Video Games Add New Dimension to Cable Television," *The Arizona Republic TV Digest*, February 6, 1983, 20–21). Most coverage at the time concluded The Games Network was "not the first cable gaming network to come into being. In 1980 a computer gaming network called PlayCable was introduced" ("Get on the Bandwagon: Computer Games by Cable," *Computer Gaming World* 2, no. 5 [1982], 25).
6. Patrick Parsons, *Blue Skies: A History of Cable Television* (Philadelphia: Temple University Press, 2008), 50.
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11. Charles L. Dages, "PlayCable: A Technological Alternative for Information Services," *IEEE Transactions on Consumer Electronics* CE-26, no. 3 (August 1980), 483, https://ieeexplore.ieee.org/document/4050339.
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13. "Video Game Shortage," *WTD* 18, no. 40 (October 2, 1978): 12.
14. Chris Welles, "The Success Capital of America," *Esquire* (July 1982): 41–52.
15. Jim Wiesenberg, in "Marketers Monitor Buying Habits, Views of Jackson Residents," *The Clarion-Ledger* (Jackson, Mississippi), December 20, 1981, 5C.
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19. "Bally Hesitates on Computer," *WTD* 19, no. 20 (May 14, 1979): 12. For other examples of 1979 PlayCable coverage see "Games Over the Cable," *Financial Times*, September 5, 1979: 13; "Jerrold Announces 'Two-way' Games for Cable TV," *Electronic Technician/Dealer* 101, no. 7 (1979): 1–4, https://www.americanradiohistory.com/Archive-Radio-Retailing/70s/ETD-1979-07.pdf.
20. Charles Dages, emails to authors, September 12, 2020 and July 12, 2021. See "TI Computer at CES," *WTD* 19, no. 21 (May 21, 1979): 13.
21. "Ready," 10.
22. "The PlayCable System Design," General Instrument (1982), PHA.
23. decle, "PlayCable," 6.
24. Dages, "Consumer," 69.
25. This flexibility was possible so long as the channels had 400 kHz of bandwidth between them. See "The PlayCable Opportunity," The PlayCable Company (1981), PHA; "The PlayCable System"; "PlayCable, The All Game Channel" [brochure], The PlayCable Company [undated], PHA.
26. "The PlayCable System."
27. decle, email to authors, February 11, 2019.
28. David Rolfe, email to authors, November 25, 2018.
29. Tony Schwartz, "Two-Way Games Channel Is Coming to Cable TV," *New York Times*, June 1, 1981.
30. "The PlayCable System."
31. "PlayCable, The All."
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37. Polskin, "Calling," 22.
38. Paul Hilt, in Steve Nicely, "Cable Firms May Use Video Games for Bait," *Kansas City Times*, October 2, 1981.
39. Nicely, "Cable."
40. Polskin, "Calling," 22.
41. "The PlayCable Opportunity."
42. "Ready" 5; "PlayCable, The All"; Patrick Clark, "No Wooden Nickels for TV Game Biz," *Daily News* (New York), February 15, 1982: 184.
43. Jim Wright, "Cable Option to Provide 15 Games a Month," *The Record* (Hackensack, NJ), November 12, 1981: B23.
44. "Cable Comes Alive!" (brochure), The PlayCable Company (1981), https://www.intellivision.us/intvlibrary/Misc/Play_Cable/gallery.php.

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45. "PlayCable Consumer Advertising Chronology," The PlayCable Company (1983), PHA.
46. "PlayCable Consumer."
47. "Introducing America's Only All Game Channel!" [advertisement], *Poughkeepsie Journal*, November 22, 1981: 8C.
48. Clark, "No."
49. Clark, "No."
50. Polskin, "Calling," 20.
51. decle, "PlayCable," 8.
52. See decle, "PlayCable," 8. The original "Jerrold PlayCable" adapter used many off-the-shelf components and supported EPROMs. As a result, it was a "hacker's paradise" that could be used to transfer videogame code to a computer using cassette tape (decle, "PlayCable," 36). This was once implemented by two Jerrold engineers, Joe Jacobs and Dennis Clark. They created an Intellivision development tool and eventually a conversion of the arcade game *Bump 'N' Jump*, which Mattel Electronics purchased and distributed under its own name (decle, "Intellivision Development, Back in the Day," *AtariAge*, June 12, 2020, 26, https://forums.atariage.com/topic/259003-intellivision-development-back-in-the-day/).
53. The two surviving schedules show no months with identical offerings ("Fall Line-Up," *PlayCable Scorecard* 3 [Fall 1982]: 4, PHA; "Programming Schedule January–April, 1983," The PlayCable Company [1983], PHA).
54. decle, "PlayCable," 21.
55. "PlayCable: You Can Have Instant Access to an Electronic Library," *Mechanix* (October 1980): 36–37. A recording of the song exists (Dave Idmarx, "Intellivision PlayCable Ragtime Song," March 25, 2017, https://www.youtube.com/watch?v=lDfvzo4vAsA).
56. "PlayCable, The All"; "Ready"; "The PlayCable Opportunity."
57. decle, "PlayCable," 23; Michael Roode, "Memories of PlayCable," *Classic Gamer* 2, no. 1 (2004): 16.
58. See John Downs, Frank Vetere, and Steve Howard, "Paraplay: Exploring Playfulness around Physical Console Gaming," in *Human-Computer Interaction—INTERACT 2013*, ed. Paula Kotzé et al. (Berlin: Springer, 2013): 682–699.
59. Roode, "Memories," 16; see decle, "Playcable," 29.
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61. Robert Bowden, "New TV System to Use Cable for Home Delivery of Adult Video Games," *Tampa Bay Times*, May 26, 1980: 6D; "Age of Aquarius in Doubt," *WTD* 23, no. 32 (August 8, 1983): 12–13; Simon Applebaum, "PlayCable Pulls Plug," *CableVision*, February 20, 1984, 16.
62. Smith, "Playing," 89.
63. Gary Stein, in Laura Landro, "Tuning in a Videogame Channel on Your TV," *Wall Street Journal*, March 16, 1983; Smith, "Playing," 75.
64. Janice Hanson, "PlayCable Research Presentation" [MRD No. IN4682], June 25, 1982, Cory Schwartz archive.
65. By late 1982 PlayCable advertising campaigns included a $50 rebate toward an Intellivision purchase ("PlayCable Consumer," 10; see, for instance, "The Best

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Deal on Video Games Just Got Better" [advertisement], *Poughkeepsie Journal*, August 29, 1982, 17B).

66. Paul Hilt, email to authors, September 21, 2020.
67. Bob Brewin, "Pay for Play," *Panorama* (March 1980): 93, www.americanradiohistory.com/Archive-Other-Documments/Panorama-TV/Panorama-TV-1980-03.pdf.
68. Moskovitz, in Nurminen and Reynolds, "Episode 40."
69. Four "Goldenrod" status reports on PlayCable videogame releases exist, covering January and February 1982. During this time only three newer titles were listed as available (*Space Hawk*, *Star Strike*, and *Utopia*), with seventeen other titles stuck in limbo.
70. "PlayCable Features & Benefits Checklist," undated, PHA.
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72. Paul Hilt, email to authors, September 21, 2020.
73. "PlayCable's Owners Are Reviewing the Operation," *Los Angeles Times*, September 21, 1983: 56; Applebaum, "PlayCable."
74. "Video Games on Cable," *Vancouver Sun*, June 18, 1982, G2; Andrew Pollack, "Video Games Still Growing," *Dayton Daily News* (Dayton, Ohio), November 21, 1982, 11.
75. David D. Thornburg, "Computers and Society," *Compute! The Journal for Progressive Computing* 3, no. 1 (1980), 14, https://www.colorcomputerarchive.com/coco/Documents/Magazines/Compute%20(Clean)/Compute_Issue_008_1981_Jan.pdf.
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77. Paul Hilt, email to authors, September 21, 2020.

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2. Nathan Altice, *I AM ERROR: The Nintendo Family Computer/Entertainment System Platform* (Cambridge, MA: MIT Press, 2015), 65.
3. Don Daglow, "New Game Ideas" [memorandum 0483–19 to Daglow Group Members], April 28, 1983, Blue Sky Rangers archive (BSR).
4. Altice, *I*, 65; see James Newman, "Cuthbert Goes Cloning: Ports, Platforms, and the Dragon 32 Microcomputer," in *Perspectives on the European Videogame*, ed. Víctor Navarro-Remesal and Óliver Pérez-Latorre (Bristol: Bristol University Press, 2021): 111–128.
5. "Atari-Intellivision TV Battle," *New York Times*, December 14, 1981.
6. Craig Spitzer, "Marketing Research Perspectives on Videogame Hardware, ECS and Home Computers, Videogame Software," July 25, 1983, CSA.
7. By March 1982, Atari had 70–75 percent market share; Intellivision, 10–15 percent ("Sony's Quarter," *Weekly Television Digest with Consumer Electronics* (*WTD*) 22, no. 12 (March 22, 1982): 10; Laura Landro, "New Video-Game Makers Jump Into Fight For a Share of the Booming Home Market," *Wall Street Journal*, January 27, 1982: 29; Janice Hanson, "ORC Video Game Tracking Study" [MRD No. IN1181], March 22, 1982, CSA).
8. Bruce's work helped with the development of Intellivision II (chapter 8).
9. Tekla S. Perry and Paul Wallich, "Design Case History: The Atari Video Computer System," *IEEE Spectrum* 20, no. 3 (March 1983): 48.

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10. "Notes on Atari VCS," [no author or date], BSR.
11. Mark Urbaniec, "Seminars for Wednesday, June 30, 1982," June 28, 1982, BSR.
12. Perry and Wallich, "Design," 48.
13. This number is for the NTSC televisions used in the United States: Atari could produce only 104 on a PAL (Phase Alternating Line) television.
14. "Coleco Airs Football Comparison Spot." *Playthings*, vol. 78, no. 2 (February 1980): 29; "Can You Afford to Be Without Coleco?", *Playthings*, vol. 78, no. 1 (January 1980): 99.
15. Andrew C. Brown, "Cashing in on the Cartridge Trade," *Fortune*, November 15, 1982, 125.
16. For instance, Atari programmers received "no royalties—and Atari then made a fortune on their games without giving them credit" (Nick Montfort and Ian Bogost, *Racing the Beam: The Atari Video Computer System* (Cambridge, MA: MIT Press, 2009), 60).
17. Heather Edison (later Brendel), "The ZZap! (POW) Cartridge" [memorandum to Bill Gillis], January 6, 1982, Heather Brendel archive (HBA); Chuck Rudd, "Refund of California Sales and Use Tax Paid on Purchases of Custom Computer Programs" [memorandum to Bill Lavere], November 23, 1982, BSR.
18. Tom Loughry, email to authors, January 26, 2023.
19. Mattel Electronics eventually pursued retention strategies. A long-awaited plan released in July 1983 included royalties up to $0.06 per cartridge and advance payments up to $10,000 per cartridge (Gabriel Baum, "Incentive Plan (to All Personnel)" [memorandum], July 6, 1983, BSR).
20. A "copyright lockout check" was added to Intellivision II's EXEC, which verified that a cartridge ROM had copyright dates 1978–1982 or that a special bit was set to generate a keyclick sound when pressing a button on the controller (Joe Zbiciak, email to authors, January 1, 2020; Keith Robinson, "Intellivision II," *Blue Sky Rangers*, accessed August 15, 2023, http://history.blueskyrangers.com/hardware/intellivision2.html). Since third-party developers rarely used the copyright feature and would not know of the special bit, their cartridges would theoretically not work, though it was ultimately an ineffective strategy.
21. Brian Dougherty, email to authors, March 15, 2021.
22. Dougherty, email.
23. Steve Bloom, *Video Invaders: Everything You Want to Know about Video Games Plus How to Beat Them!* (New York: Arco Publishing, Inc. 1982), 111; see Montfort and Bogost, *Racing*, 101.
24. Bloom, *Video*, 111.
25. Cory Schwartz, "Concept Appeal Test for 1983 Intellivision Software—Revised Proposal" [MRD No. IN–0583–0–P], January 31, 1983, BSR. The proposal was earmarked for Don Daglow, Mike Minkoff, and Richard Timmins, who managed videogame designers.
26. Schwartz, "Concept."
27. Cory Schwartz, "Concept Appeal Test for 1983 Intellivision Software" [MRD No. IN0583], April 19, 1983, CSA.
28. Daglow, "New."
29. David Stifel, "Seminar for Thursday, July 21" [memorandum 0783-13 to All Intellivision Programmers], July 18, 1983, BSR.

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30. Susan Prince, "Astrosmash/Astroblast," *Electronic Fun with Computers and Games* 1, no. 1 (1982): 65.
31. Gabriel Baum, "See Below" [memorandum to Intellivision Programmers], April 2, 1982, BSR.
32. A "goldenrod" summary of projects in development from December 1983 lists six additional cartridges in progress ("Development Programs Status Summary [Goldenrod]," December 20, 1983, BSR).
33. Mattel Electronics reverse engineered ColecoVision in 1983, created development tools, and displayed four titles at the January 1984 CES, but none were released before the crash (Eric Del Sesto, "Colecovision Mrcolor Users Manual," November 21, 1983, BSR; Mike Minkoff, "ColecoVision" [memorandum to Gabriel Baum], June 9, 1983, BSR; Sharon Verduzco, "WCES—1984—Booth Layout" [memorandum to Mike Doepke, Steve Lapinski, and Gary Moskovitz], November 21, 1983, BSR). Coleco also engaged in this transplatform practice, releasing Intellivision games.
34. "Mattel Electronics Presents *BurgerTime*" [promotional packet for Wendy's franchises], 1983, Ray Kaestner archive.
35. Keith Robinson, "*BurgerTime*," *Blue Sky Rangers*, accessed August 16, 2023, http://history.blueskyrangers.com/mattelelectronics/games/burgertime.html. Much of Mattel Electronics' international development focused on such work, with Mattel Electronics Limited Taiwan (MELT) making software for Apple II and Mattel Electronics Limited Hong Kong (MEL HK) making software for the Aquarius computer.
36. Keith Robinson, "*BurgerTime* [M Network]," *Blue Sky Rangers*, accessed August 16, 2023, https://history.blueskyrangers.com/mnetwork/burgertime.html.
37. Robinson, "M Network." Mattel executives had considered developing a "Super Charger" hardware extension for Atari to provide more RAM and other features, but they canceled it, necessitating additional memory on the *BurgerTime* cartridge.
38. Surratt used Atari's "missile" sprite to represent enemies since this did not cause flickering when multiple enemies were on a single, horizontal line, with the trade-off that the enemies appeared as rectangular shapes (Robinson, "*BurgerTime* [M Network]"). Mattel Electronics programmers shared tips for reducing flicker in Atari games (Jeff Ratcliff, "Beyond Triple Mode (or How Atari May Have Done Galaxian)," undated, BSR).
39. Don Daglow, "It Is My Sad Duty" [memorandum 0483–07 to Applications Software Staff], April 7, 1983, BSR.
40. "Mattel Sues Atari," *WTD* 23, no. 19 (May 9, 1983): 14.
41. "Atari Suit Filed by Mattel," *New York Times*, May 4, 1983: 86.
42. Similarly, at Imagic, Dougherty recalled writing a 2KD EXEC stored on each 8KD cartridge.
43. Newman, "Cuthbert," 112.
44. Harrower, "AY-3-8900-1: Customer Procurement Specifications," April 29, 1982, 6.3, *Papa Intellivision*, http://papaintellivision.com/pdfs/CCF10232011_00012.pdf.
45. Harrower, "AY-3-8900-1," 6.2.
46. Ralph J. Watkins, *A Competitive Assessment of the U.S. Video Game Industry: Report on Investigation no. 332-160 Under Section 332(b) of the Tariff Act of 1930* (Washington, DC: United States International Trade Commission, 1984), 10.
47. Bohus, "The ColecoVision Add-On that Started All the Trouble," *Retro Thing*, April 20, 2010, https://www.retrothing.com/2010/04/colecovision-addon-that-start

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ed-all-the-trouble.html. Atari sued ColecoVision for $500 million in damages but lost the case (Coleco agreed to pay royalties). ColecoVision also released the "Gemini," a standalone clone of the VCS (Bohus, "Coleco Gemini—First Atari 2600 Clone," *Retro Thing*, June 19, 2006, https://www.retrothing.com/2006/06/coleco_gemini_f.html).

48. The System Changer was intended to be paired with the forthcoming Intellivision II, which was given the ability to "accept an external video signal on pin 2 of the cartridge port and pass it to the RF modulator" (Keith Robinson, "System Changer," *Blue Sky Rangers*, accessed August 16, 2023, http://history.blueskyrangers.com/hardware/systemchanger.html). Owners of the original Intellivision had to send it in for a circuit board modification.
49. Atari eventually produced its own VCS Cartridge Adaptor for the Atari 5200 console so it could play 2600 games, "a reactionary move on Atari's part, in response to competitors Coleco and Mattel releasing their own 2600-compatible hardware" (Altice, *I*, 300).
50. Cory Schwartz, "Most Games' Commercial Test Results—Final Report" [MRD No. IN-2083–7-F], May 25, 1983, CSA.
51. "Intellivision Module Accepts Atari 2600," *Playthings* 81, no. 4 (April 1983): 48.
52. Scott Stilphen, "The Secrets to the VCS's Longevity," *Atari Compendium*, accessed August 16, 2023, https://www.ataricompendium.com/archives/articles/longevity/longevity.html.
53. Stilphen, "The Secrets."
54. Kathy Kennedy, "Intellivision Entertainment Computer System Offers All the Right Connections" [news release], Mattel Electronics, 1983; Charlene Margaritis, "Intellivision II Plus System Changer—The Most Games the Best Games" [news release, undated, likely mid-1983], BSR.
55. Spitzer, "Marketing."
56. Laura Kalb, "Portofino Viability Study—Quantitative Phase" [MRD No. IN2882b], February 18, 1983, CSA; Mack Morris, "Mattel Electronics: Where We Are, Where We Are Going, How We Will Get There" [memorandum to Mattel Electronics employees], November 2, 1983, BSR.
57. Laura Kalb, "Portofino Viability Study—Focus Groups" [MRD No. IN2882a], January 14, 1983, CSA.
58. Altice, *I*, 301.
59. Blake J. Harris, *Console Wars: Sega, Nintendo, and the Battle That Defined a Generation* (New York: HarperCollins, 2014).
60. Tarleton Gillespie, "The Politics of 'Platforms,'" *New Media & Society* 12, no. 3 (2010): 347–364, https://doi.org/10.1177/1461444809342738.

Chapter 13

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2. Frost & Sullivan, *Home and Coin Operated Electronic Games* [Report #650] (New York: Frost and Sullivan, Inc., 1979), 16; see "Video Game Rollercoaster," *Weekly*

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Television Digest with Consumer Electronics (*WTD*) 18, no. 48 (November 27, 1978): 11; Mark J. P. Wolf, "The Video Game Industry Crash of 1977," in *Before the Crash: Early Video Game History*, ed. Mark J. P. Wolf (Detroit, MI: Wayne State University Press, 2012): 81–89.

3. Mirko Ernkvist, "Down Many Times, But Still Playing the Game: Creative Destruction and Industry Crashes in the Early Video Game Industry 1971–1986," in *History of Insolvency and Bankruptcy from an International Perspective*, ed. Karl Gratzer and Dieter Stiefel (Huddinge, Sweden: Söderstörns Högskola, 2008), 175.
4. "Electronic Games," *WTD* 20, no. 6 (February 11, 1980): 10.
5. Ralph J. Watkins, *A Competitive Assessment of the U.S. Video Game Industry: Report on Investigation no. 332-160 Under Section 332(b) of the Tariff Act of 1930* (Washington, DC: United States International Trade Commission, 1984), 13; "What Wholesalers and Retailers Are Saying," *Playthings* 77, no. 2 (February 1979): 82.
6. Allen McCusker, "Mattel Electronics Strategic Plan Evaluation" [memorandum to Bob Anderson], September 11, 1980, Mike Welch archive.
7. Janice Hanson, "ORC Video Game Tracking Study" [MRD No. IN1181], March 22, 1982, Cory Schwartz archive (CSA).
8. Ernkvist, "Down," 179.
9. "Mattel's Intellivision," *Weekly Television Digest with Consumer Electronics* (*WTD*) 22, no. 39 (September 27, 1982): 13; "In Other Activity," *WTD* 22, no. 41 (October 11, 1982): 12.
10. Spencer Boise, "For Immediate Release" [December 1982 Sales Report], December 9, 1982, Blue Sky Rangers archive (BSR).
11. Boise, "For Immediate Release" [December 1982]."
12. "Mattel Posted," *WTD* 23, no. 12 (March 21, 1983): 15.
13. Until December 1984 (after the closing of Mattel Electronics), Mattel's fiscal year ended on "the Saturday nearest January 31" (*Mattel Toys Annual Report to Shareholders for the year ended December 29, 1984* (Hawthorne, CA: Mattel, Inc., 1984)). A fiscal year running from February 1 to January 31 included the entirety of each holiday shopping season.
14. Watkins, *A Competitive*, 45. Licensing contributed to overextension and the crash as well: "Incredible amounts of money were paid for licenses on Woody Woodpecker and Hanna-Barbera cartoon characters. The products weren't created yet, and the licensing fees were still due" (Chris Barnett, "Mattel Rises. Again," *Los Angeles Magazine* (December 1985), 333).
15. "Videogames Take SCES by Storm," *Merchandising Show Hotline*, June 7, 1982, Mike Doepke archive.
16. Mike Doepke, in "Videogames." By 1983 "at least 30 independent companies manufactured game cartridges as their principal product" (Watkins, *A Competitive*, 45).
17. Spitzer, "Marketing."
18. Redesigning titles for Marvin Kempner's TV POWWW! (chapter 7)—which allowed viewers to play videogames by calling into a TV program—also diverted staff resources. From Kempner's perspective, overextension was siphoning creative energy from Intellivision game design for TV POWWW! Kempner complained, "Mattel was fast losing interest in their electronic game division" because "their real plans were to sell an $845 toy, namely—a home computer"; they were spending "more and more time on their computer and less on games" (Marvin A. Kempner,

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Can't Wait till Monday Morning: Syndication in Broadcasting (New York: Rivercross Publishing, 1998), 216.).

19. "Peaches" was a project to create 3D glasses developed by Richard Steenblik at the Georgia Institute of Technology. Programmers Keith Robinson, Steve Ettinger, and Joe Ferreira (later King) developed the videogame "Hover Force 3-D" that used the glasses. Steenblik recalled that at the 1984 Winter CES, "people were lined up to play. It was the hit of the show." The title never appeared before the crash but was released in 1986 as *Hover Force* (without 3-D). As far back as 1978, Mattel Electronics staff explored the possibility of "Pictureware," an interactive videotext system using Intellivision along the lines of Minitel in France and Prestel in the United Kingdom (David Chandler, "Report on Prestel International Forum" [memorandum to Ed Krakauer, Jeff Rochlis, Al Secor, and Chuck Rudd], January 28, 1980, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00023.pdf; Stephen Maine, "Home Entertainment Terminal" (schematic drawing), March or April 1978, Stephen Maine archive). Bill Gillis and then Gary Moskovitz were involved in attempts to develop home terminals known as "Pronto," "Viewdata," "Intelliphone," and "Intelliputer," but these various projects were abandoned. Mattel Electronics also pursued a console with Sony. "SonyVision" might have taken the form of a "flat, color, portable Intellivision" with an "advanced combination disc (audio/video/digital)" storage technology (Stav Prodromou, "Proposal: Sony/Mattel Electronics Joint Study Team Objectives," September 7, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10242011_00005.pdf). The deal fell apart by early 1983. Also, in early 1983 Mattel Electronics leadership entered an agreement to share information with North American Philips (parent company of Magnavox) about next-generation systems and test future collaborations (Stav Prodromou, "NAP [North American Phillips] Meeting" [memorandum to David Chandler], February 9, 1983, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00029.pdf).
20. Heather Edison (later Brendel), Journal (personal), Heather Brendel archive.
21. David Chandler, "Outline—Major Options for Intellivision Systems," undated, likely fall 1981. Paul Chandler archive (PCA).
22. "Design Objective Specification AY-3-89000," General Instrument, undated, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00013.pdf. Signifying an emptiness that still needed to be fleshed out, GI called these upgraded chips the CP16000 CPU and "AY-3-89000 Advanced Video Processor," adding a zero to the end of CP1600 and AY-3-8900 (Intellivision's original chips).
23. Hostetler suspected GI was pitching its complicated chip to secure its future within multiple microchip markets and also to develop a next-generation CPU that would work with the AY-3-89000 (David Hostetler, "A Critique of the GI Advanced Video Processor DOS" [memorandum to David Chandler], December 22, 1981, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00013.pdf).
24. Hostetler, "A Critique."
25. Jason Soo [probable author], "Working Specification: Mattel Advanced Graphic Interface Circuit," July 8, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10272011_00005.pdf; "High Resolution Cards Mode," No author (possibly David Chandler), October 30, 1981, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10272011_00005.pdf.

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26. Mike Spak, "Mattel Custom (MAGIC) Die Size Estimate" [Motorola memorandum to B. Wieder], June 15, 1982, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10272011_00005.pdf; Gasparri et al., "MOS Integrated Circuit Design Specification: Mattel Advanced Graphic Interface Circuit," Motorola MOS Integrated Circuits Division, November 12, 1982, PCA.
27. Stav Prodromou, email to authors, January 10, 2020.
28. Keith Robinson, "Intellivision IV," *Blue Sky Rangers*, accessed August 17, 2023, http://history.blueskyrangers.com/hardware/intellivision4.html; Soo, "Working."
29. Chandler, "Outline—Major."
30. Project Laurie was envisioned to be "resident on Mattel or non-Mattel hardware," and Decade was a likely candidate for a version of the software (David Chandler, Jerry Comisar, and Laurie McDaniel, "Project Laurie," undated, Laurie Vertelney archive (LVA)).
31. Chandler, Comisar, and McDaniel, "Project."
32. Chandler, Comisar, and McDaniel, "Project."
33. Laurie McDaniel, Project Laurie storyboard, undated (likely April 1983), LVA.
34. At APh the new console and EXEC were called "APhix" ("APh" plus "Unix").
35. Walter Ives, "New Intellivision Console Coming?" *AtariAge*, September 1, 2022, https://forums.atariage.com/topic/339768-new-intellivision-console-coming/page/3/#comment-5165346.
36. Ray Kaestner and John Spies, "STIC 1B Specification" [memorandum 0283–09 to Mark Urbaniec], February 16, 1983, BSR. This may represent the first attempt at integrated backward compatibility in the videogame industry. One discussion claimed "Mattel have made all their machines 'upwardly compatible,'" referring to what is now known as "backward compatibility" but drawing on the notion of upward mobility ("Factfile: Intellivision," *TV Gamer* 3 [Winter 1983]: 23).
37. "Preliminary Target Specification: Intellivision III," undated (likely late 1982), no author listed, *Papa Intellivision*, https://papaintellivision.com/pdfs/CCF10232011_00017.pdf.
38. "Preliminary." Preliminary specifications also called for a "CP1610-2" CPU that would have a "compatible mode" for existing Intellivision cartridges and a caffeinated, "upgraded mode" operating twice as fast as the original Intellivision's CP1610. APh used an improved CPU CP1610A (developed for Intellivision II) that could run twice the speed of the original CP1610 without overheating (Ives, "New").
39. "Mattel Electronics Revolutionizes Home Video Games with a New State-of-the-Art Product Introduction," undated news release, BSR.
40. Gabriel Baum, "Coffee [CES]" [memorandum to Josh Denham, Hugh Barnes, and Stav Prodromou], January 24, 1983, BSR; "Master Component Scheduling Accuracy—Pre-Code and Final Code Releases, November 9, 1982–April 8, 1983," undated, BSR.
41. Don Daglow, "President's Awards" [memorandum 0583–12 to Gabriel Baum], May 10, 1983, BSR.
42. Ken Uston, "CES: Another Perspective," *Creative Computing* 9, no. 4 (April 1983), 52, https://www.atarimagazines.com/creative/v9n4/52_CES_another_perspective.php.
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49. Roger C. Sharpe, "A Merry-Go-Round: Will 1983 Pick Up where 1982 Left Off?" *Play Meter* 9, no. 3 (February 15, 1983), 52.
50. Boise, "For"; see Dan Dorfman, "Bulls Betting on Mattel but Not Everyone Shares That Faith," *Miami News*, May 30, 1983: 19; "Game Market Sag," *WTD* 22, no. 50 (December 13, 1982): 15.
51. Craig Spitzer, "Intellivision II/Intellivision III Hand Controller Tests" [MRD No. IN1383]. March 10, 1983, CSA; Ron Gross, "Intellivision III Remote Controller Appeal Study" [MRD No. IN2683], May 6, 1981, CSA; Dave Warhol, "Seminars for Wednesday, April 20" [memorandum 0483–10 to All Intellivision Programmers], April 18, 1983, BSR.
52. Robinson, "Intellivision III"; Ralph Linne, "The Mattel Intellivision," *Digital Press Classic Videogames Collector's Guide*, 2002, 44, https://www.digitpress.com/dpg_plug_classic.htm. A May 1983 marketing study emphasized that given industry concerns about Intellivision's viability, "we need to position withdrawal of Intellivision III at CES very carefully" (Ellen Holden, "Ogilvy & Mather Qualitative Survey of the Video Game and Home Computer Buyers" [MRD No. IN4583], May 9, 1983, CSA).
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