Global Controller:

Making the Musical Instrument Digital Interface, 1983-1999

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August 2014
(Revised March 2015)

A thesis submitted in partial fulfillment of the requirements
of the Doctor of Philosophy degree

ACKNOWLEDGEMENTS

Countless thanks to the faculty, staff, and students of the Department of Art History and Communication Studies at McGill University – first and foremost to my supervisor Dr. Jonathan Sterne, and a special thanks to Dr. William Straw for his unflagging support and guidance throughout. Thanks to Dr. Darin Barney for his assistance in the evaluation of my comprehensive exam and thesis proposal defence, and to Graduate Program Director Matthew Hunter. I am eternally grateful to Maureen Coote and Susana Machado for their administrative support and tireless efforts in the Departmental office. I drew strength, insight, and patience from my 2014 sound culture students who infinitely inspired me with their tenacious curiosity and unbridled energy. Grandescunt Aucta Labore.

My research was generously funded by the Social Sciences and Humanities Research Council of Canada, Media@McGill, and the substantial support of Drs. Sterne and Straw. I am tremendously indebted to the participation of the North American Music Merchants in Carlsbad, California, and particularly the benevolent and welcoming assistance of Tony Arambarri, Dan Del Fiorentino, and Katie Wheeler at NAMM's Resource Center. Thanks go out also to Brian Vincik, Marco Alpert, and Dave Rossum for their personal participation. Of course, this dissertation would not have been possible without Dave Smith of Dave Smith Instruments, and Ikutaro Kakehashi of Roland Corporation.

Massive outs to Roger Tellier-Craig, Tim Hecker, Patti Schmidt, Craig Campbell, Nick Maturo, aAron Munson, Clarice Eckford, Mitchell Akiyama, Francesco de Gallo, JLK, Vicki Simon, Mr. Beatnick, and Buds MacLachlan for their friendship and moral support. Big ups to Frances Morgan and Jennifer Lucy Allan at *Wire* magazine, John Doran, Luke Turner, and Rory Gibb at *The Quietus*, Kiran Sande of *Fact* and Blackest Ever Black, Trevor Pinch at Cornell, Paul Théberge at Carleton, Haidee Wasson at Concordia, Yoke-Sum Wong and Derek Sayer at Lancaster, all at Casa Del Popolo, and Emily Mackay, Emilie Friedlander, Maya Kalev, Chal Ravens, Sophie Coletta, Adam Harper, and Simon Reynolds for their brilliance.

In the house, yeah: William Bevan, Andy Stott, Pete Swanson, Laurel Halo, Holly Herndon, Bill Kouligas, Lee Gamble, Dan Lopatin, Rashad Becker, Robert Hood, Steve Goodman, Paul Purgas, Dominick Fernow, Terre Thaemlitz, Mark Fell, Marc Dall, Helena Hauff, Camella Lobo, Juan Mendez, James Ruskin, Karl O'Connor, Peter Sutton, Darren J. Cunningham, Gary Grice, Robert Fitzgerald Diggs, Andre Romelle Young, Liam Howlett, Tom Rowlands, Ed Simons, Norman Cook, Thomas Bangalter, Guy-Manuel de Homem-Christo, Rupert Parkes, Geoff Barrow, Richard D. James, Rob Brown, Sean Booth, Clifford Joseph Price, Adrian Thaws, Dieter Meier, Boris Blank, Jan Hammer, Harold Faltermeyer, Vince Clarke, Martin Gore, Brian Eno, Genesis Breyer P-Orridge, Maggi Payne, Enya Brennan, Wendy Carlos, and the late Bob Moog, Dwayne Goettel, Ian Loveday, John Balance, and Peter Christopherson. Absolute existence, absolute motion, absolute direction, absolute Truth. NOW, HERE, US.

Finally, bountiful thanks to my parents, Iris Popowich and Taras Diduck, for their unconditional love and support. This thesis is dedicated in loving memory to my grandparents Alexander and Margaret Popowich, and William and Eva Diduck.

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ABSTRACT

Global Controller examines the creation of the Musical Instrument Digital Interface, or MIDI, since its public announcement in 1983. Through careful analyses of interviews and musical instrument business documents, it highlights the process by which MIDI came into existence, and its influential role as a technical standard in the digital musical instrument ecosystem. Ideas about the intersecting synthesizer and computer industries, and a review of the emergent body of standards and music technology literature are presented in the Introduction. Chapter 1 advances a case for "claviocentrism:" or, the centrality of piano keyboard-based instruments in Western music-making traditions. It examines the thousand-year history of clavier devices, and considers the drive towards musical automata. Chapter 2 looks at pre-MIDI interfaces, and early moves towards connecting digital instruments. Through interviews with musicians and engineers, the path towards MIDI's establishment is traced through various competing musical genre and technological innovations. Chapter 3 considers the roles of multifarious professional associations in the creation of MIDI. The North American Music Merchants, the MIDI Manufacturers Association, and the International MIDI Association are discussed, while questioning the user's role in shaping the MIDI specification. Chapter 4 considers a number of industry studies commissioned in the 1990s to capitalize on the success of MIDI in the musical instrument marketplace. The chapter focuses on the growing relationship between MIDI and the computer business, and the development of new digital audio musical products. Findings from these analyses, and a discussion of post-MIDI music making practices are summarized in the Conclusion.

RÉSUMÉ

Global Controller se penche sur la création du protocole "Musical Instrument Digital Interface", ou MIDI, à partir du moment où il fut annoncé publiquement en 1983. En analysant minutieusement une panoplie d'entrevues et de documents commerciaux d'instruments de musique, le texte met en lumière le processus par lequel cette technologie est entrée en existence, ainsi que son rôle influent dans l'élaboration d'un standard technique au sein de l'écosystème des instruments de musique numériques. L'introduction comporte une réflexion sur l'intersection des industries informatiques et des producteurs d'instruments de musique électronique, ainsi qu'un examen du corpus émergent d'une littérature des standards et technologies de la musique. Le premier chapitre avance l'idée du "claviocentrisme", c'est-à-dire, le rôle central des instruments basés sur le clavier-piano dans les traditions de création musicale de l'occident. Il s'attarde aussi sur l'histoire millénaire de dispositifs pour clavier, tout en considérant cette tendance vers l'automatisation des instruments de musique. Le deuxième chapitre se concentre sur les interfaces pré-MIDI et les premières tentatives de connexion des instruments numériques. En présentant une série d'entrevues avec des musiciens et ingénieurs de son, le trajet menant à l'élaboration du système MIDI est illustrée par une gamme de différents genres musicaux et innovations technologiques. Le troisième chapitre explore le rôle considérable d'une multitude d'associations professionnelles dans la création du MIDI. La *North American Music Merchants*, la *MIDI Manufacturers Association*, ainsi que l'*International MIDI Association* y sont discutées, tout en s'interrogeant sur le rôle de l'utilisateur dans l'élaboration de la norme MIDI.

Le quatrième chapitre analyse une quantité d'études industrielles commandés dans les années 1990 afin de capitaliser sur le succès du protocole MIDI au sein du marché des instruments musicaux. Le chapitre se concentre sur la relation croissante entre le MIDI et l'industrie informatique, et le développement de nouveaux produits musicaux audio numériques. Les résultats de ces analyses sont résumés dans la conclusion, en plus d'une discussion sur les méthodes de production de musique “post-MIDI”.

MIDI: an Introduction

> "**MIDI**. Abbreviation for Musical Instrument Digital Interface, a communications protocol that allows a central electronic device, usually a keyboard or a computer, to interact with other MIDI-compatible devices, enabling one person to command several instruments at once – and to tweak, twiddle, and layer every last note and beat of a composition to one's heart's content. MIDI, which was developed by a consortium of musical-instrument manufacturers (among them Yamaha, Roland, and Korg), was viewed warily by many purists when it was introduced in 1983, but is now used by nearly all rock musicians save the White Stripes. *With all my MIDI sequencers and interfaces, I can perform The Wall without David, Rick, or Nick, God help them*." – *The Rock Snob's Dictionary*[1]

Shortly after MIDI was first demonstrated in 1983, American synthesizer maker Bob Moog summoned Jeff Rona, then-president of the MIDI Manufacturer's Association to a closed-door meeting with a representative from the Audio Engineering Society. MIDI, the new protocol for digitally controlling electronic instruments, was in the formation stages, and the MMA was researching the process of standardizing its specification officially. "He had the Coke bottle glasses," Rona recalls of the AES representative. "I mean, he was just … well, probably not a real happy guy."[2] The AES agent asked Rona if the MMA was working with the American National Standards Institute, and their X3V1 processing language task group. Rona was unaware that such a group existed. As Rona recounts, the representative then informed him that there was a very specific and methodical process for standardizing a new computer language. "Somebody comes up with an idea," Rona described cynically, "and then you have years for as many people to say why it won't work as possible." When Rona confessed to the AES rep that the MMA had done none of the canvassing and peer-review work that ANSI required, he warned, "I hope you realize you could be sued for what you're doing. Somebody could sue you for MIDI tomorrow and you'd have to stop." The reason why the specification advanced so quickly, Rona suggests, is that those involved in creating MIDI did not follow those rules. "You know how we did it?" Rona inquires rhetorically: "It was like, 'OK, so-and-so proposes that we add MIDI machine controls so you can operate tape machines. Everybody in favor say aye.' Done! It would take five minutes. If we did it the way the AES does it, it would've taken five years."[3]

MIDI is a protocol that allows one device to control another for the purposes of making music. It is a common programing language that makes musical machines compatible and interoperable, regardless of their manufacturer or brand name. In the hyper-corporate and late capitalist climate of the 1980s into which MIDI emerged, the idea of competitors coming together to agree on a universal standard seemed counterintuitive on the surface. But, in addition to falling within the musical instrument field, the synthesizer industry was also just one of many emerging technology markets, and would have to compete in a cutthroat climate along with analogue and digital electronics, computers, high-tech home entertainment, and other consumer durables. Subsequent mergers and acquisitions aside, and however reluctant a common agreement to MIDI turned out to be, the MIDI standard helped to grow an entire sector of an industry – the fledgling synthesizer business that, until that time, had been the province of professional musicians and affluent aficionados.

One of the most astonishing things about MIDI as a standard is its comparative longevity. Computer protocols tend to age faster than dog years: they are usually updated, or turn over entirely, with alarming regularity. MIDI, on the other hand, has remained the industry standard digital interface for over 30 years. Yet, despite its three-decade ubiquity – MIDI still functions as the "circulatory system" of most digital information in modern music studios – little has been dedicated to documenting MIDI's backstory, and the materials that do exist are spread loosely across popular journalistic pieces, trade papers, academic discourses and disciplines, and musical instrument industry history. So, given its centrality to the electronic music ecosystem, MIDI warrants a sustained and thoughtful appraisal.

Investigating how standards become standard often reveals interesting stories that characterize the players, implicate the politics, expose the socio-economic forces, and explore the cultural logics that shaped their course. MIDI is an anomaly as a technical standard, and it is important to document and analyze the processes by which standards form, especially those like MIDI that form via unofficial channels. It was not adopted with the rigor of, say, a pharmaceutical drug trial, or formalized according regulatory bodies of standardization like the International Standards Organization (ISO) or the American National Standards Institute (ANSI). Rather, MIDI was developed in private, by and for a few interested parties, conferred relatively quietly, and in a comparatively short span of time. Although it was not really an illegal conspiracy, it was not the warm, feel-good story of universality and consensus, either; the history of MIDI is a case study in getting things done in closed-door proceedings, and deals sealed with handshakes.

In early 2014, I traveled to the headquarters of the National Association of Music Merchants (NAMM) in Carlsbad, California, to access their archives, and collect materials for this study. NAMM has a library designated to collecting historical documents from their members – both manufacturers and music instrument dealers. Dan Del Fiorentino and Tony Arambarri run the "Resource Center," as NAMM's library is known. The pair has also interviewed thousands of musical instrument industry insiders, designers, musicians, and other key NAMM members for their ongoing Oral History program. The vast majority of raw data to be presented in this dissertation was culled from that visit, and both Del Fiorentino and Arambarri were of tremendous assistance with finding and sharing information relevant to my investigation of MIDI. In addition to a wealth of trade data such as sales statistics, market research, and consumer reports, they also archive documents from other musical organizations, associations, and philanthropic foundations. In 2013, the MIDI Manufacturer's Association donated a banker's box full of newsletters, personal correspondence, and official documents. And coincidentally, more MIDI-related materials were arriving in the door at NAMM while I was there conducting my research, including a wonderful archive of NAMM show photographs by Norwegian journalist Trond Bratten.[4]

Of the terms I intend to introduce around MIDI, the key word I will be referring to throughout this dissertation is a neologism of my own design, and hopefully one that is more useful than clever: "claviocentrism." Claviocentrism is a cultural logic within which MIDI emerged – the centrality for centuries of the piano-like keyboard in Western musical traditions. 300 years of keyboard instruments are represented in Wendy Carlos' 1968 *Switched-On Bach* recordings, in which the artist used Moog synthesizers as the instrumentation for reimagining Bach's classical compositions, stimulating fascination both in electronic music recordings, as well as with the keyboard instruments used to make them. And while Carlos was influential in 20th century Classical, Avant-Garde, and Progressive Rock music circles, the impact of her work was felt perhaps with even more force for MIDI in cycles of instrumental, organ, and other electronic keyboard recordings, on cheesy easy listening albums like Christopher Scott's 1969 *Switched-On Bacharach*. The history of MIDI, in a sense, is also a history of both high and low claviocentric musical cultures.

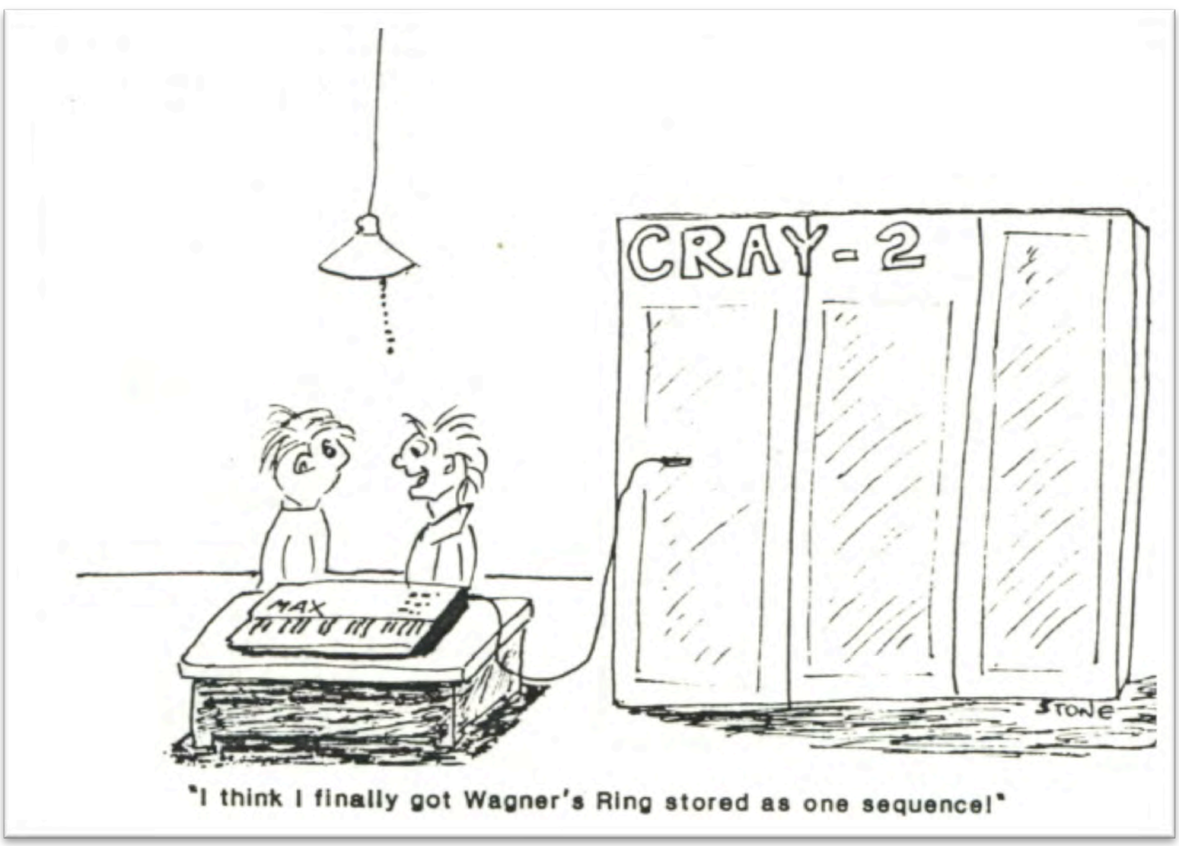


Figure 1: Cartoon from "MIDI Gritti," the Sequential Circuits Newsletter, February 1985. MMA Archives.

The additional overarching argument that I will propose is that MIDI was made by a process of associations, alliances, and encumbered by professional and personal conflicts – all under the guiding hand of NAMM. MIDI was first demonstrated at the NAMM show in 1983, and since then, has been among its favorite pet projects – a technological innovation they take great pride in being associated with.[5] In effect, and in absence of recognized regulatory bodies, NAMM became the de facto steward of the MIDI specification. Put simply, it was a bit of a rush job that never would have passed muster within a more demanding professional organization.[6] This tells us that MIDI might have been, in effect, a substandard standard; but somehow, it was worth enough to a sufficient number of key players to support. Subsequently, NAMM invested significant time and money into propping up the spec in the eyes of the consuming public, selling the idea of MIDI as a comprehensive and easy-to-master technology, as well as giving a forum for all the new MIDI-capable instruments that would be coming to market as a result of its swift adoption. MIDI became the high watermark of 20th century music technology – a feat the industry tried time and again to replicate.

Literature Review

More than the MMA's archives, the International MIDI Association, which was the first organization to hold the MIDI copyright, proved a rich resource. The IMA published monthly bulletins between MIDI's adoption in 1983 and the early 1990s, spearheaded the MIDI Users Group, and kept meticulous records of the specification itself, its implementation in keyboards of the day, and information regarding early MIDI demonstrations, associational meetings, committees, and other loosely formed groups around the specification. In addition, NAMM shared with me 55 MIDI-tagged Oral History videos, a number of surveys and reports, and details about the MIDI Task Force, an ad-hoc committee formed in the late 1990s to create MIDI 2.0.

Richard F. Moore's Spring 1988 *CMJ* article entitled "The Dysfunctions of MIDI" is devoted to finding MIDI's musical faults, among which he lists machine control, digital representations of analogue processes, interfaces, and environments, and "performance capture."[7] Moore discusses expressive vs. communicative acoustical interaction – for example, the difference between speech and song – and what he terms "sound sculpting:" when "all aspects of the sound are determined in advance of its audition by the listener."[8] With Moore's litany on how MIDI should have been improved (but was not), he anticipated the rise of digital audio workstations, and the industrially driven (Gordon) Moore's law of exponentially increasing microprocessor speeds over the late 1990s.[9]

In addition to producing tones that no other instrument could, many analogue synthesizer manufacturers made a project of emulating the sound of acoustic instruments and other natural phenomena of the soundscape. Politis et al. hint toward MIDI's preoccupation with emulation in their 2008 article examining the synthesizing of Ancient Greek music after historical notation.[10] From few surviving sources, researchers first reconstructed a score of how Ancient Greek music might have sounded, and then programed digital instruments interfaced through MIDI to approximate the often unharmonious and atonal musical structures. As we shall see, MIDI was based on an altogether different harmonic system – a keyboard-centered scale of discrete and tempered tones.

Alan Belkin and Christopher Yavelow wrote in the *CMJ* (and elsewhere) on MIDI as a compositional tool, and the Apple Macintosh computer as a primary sequencer: the master notational device for MIDI programming.[11] In his 1986 article "MIDI and the Apple Macintosh," Yavelow noted the number of new musical software programs that had been developed specifically for those computers, and explained how MIDI affected music software development, from basic internal sound-generating capacity to the control of multiple sound-making instruments, external devices, and audio hardware. Belkin's work surveys a handful of Mac-dedicated MIDI notation software; his concern here is with scores and music publishing in the face of its digitization. Interestingly, Belkin concludes with MIDI's industrial modus operandi: that cooperation will better serve the cause of quality. Although Apple Computer cooperated with the MIDI concept in the early days, they benefited more from keeping a healthy distance and allowing third parties to develop music software and hardware after the 1990s. The computer business profited immensely from the adoption of MIDI as computers and software gradually became central to digital music composition. As well, the computer and musical instrument industries comingled in important ways, cross-pollinating each sector with novel ideas and technological innovations.[12]

There is a small but strong tradition of academic work into the formulation and adoption of industry standards and classifications. Lewis Mumford's *Technics and Civilization* will enlighten my considerations of MIDI and its networked music making machines, MIDI being at once its own discrete kind of machine, one in a series of machines, a byproduct of another set of machines, and a "functional" modern technic.[13] MIDI embodies not only a technology but also a mode of cultural operation; Mumford's thinking will be a valuable cornerstone when parsing MIDI's cultural history. Methodologically, I will follow Alexander Galloway's *Protocol: How Control Exists After Decentralization* to provide a grounding of my discussion of MIDI as a protocol designed to control flows: signals between machines; information between players in the MIDI ecosystem; capital within a high-stakes entertainment industrial complex, &c.[14] The history of MIDI is on one hand a story of liberation – from technological constraints, from human limitations. Once MIDI was conferred, it was essential to distribute the specification as far and wide and freely as possible. Yet, despite the rhetoric of freedom and liberation, the power to make adjustments or enact significant changes to the protocol was tightly controlled. Matthew Fuller's ecosystemic approach to media history will serve as a useful guide, to attend to the host of actors, human and not, that have shaped MIDI's development and implementation, and give direction to an energetic and materialist account of them.[15] Non-human agency is found in things like, for example, ports and cables where loose connections can contribute noise rather than signal; peripheral devices and dongles that quickly become incompatible or obsolete; discs, drives, and data storage whose surfaces wear from inscription and reinscription by ever-newer formats of binary code; wireless networks that function intermittently; and most importantly, the unexpected.

Bowker and Star's *Sorting Things Out* will provide the background for my discussion of MIDI as the chosen interfacing language, arrived at under an assortment of historical, cultural, and economic forces; Lampland and Star's anthology *Standards and Their Stories* recounts how ideas themselves become standard, and is a useful model upon which I will craft the tales behind the standardization of MIDI.[16] MIDI did not take the "standard" path towards standardization – if such a thing exists. As Jeff Rona's story above illustrates, the decision-making process was sped through to the detriment of rigorous and fertile dialogue. Choices may have been made in five seconds rather than five years, but was this such a good thing? And who was in the room for those conversations? Just how open was the discourse around MIDI? Unlike the arbitrary bodies that normally ratify standards and classifications, everyone involved in conferring MIDI had an economic investment in the exchange: they all wanted to sell their own products. Although MIDI may not have followed standard operating procedure, its process does shed light on how the organized instrument-making industry did business across its 100-year history.

The musical instrument trade is the focus of a wealth of research. Alfred Dolge's 1911 *Comprehensive History of the Development of the Piano*, along with the extensive work of Arthur W.J.G. Ord-Hume, will help to sculpt my discussion of claviocentrism, and establish the keyboard's historical place within an industry that manufactured both mechanically reproducible products and artifacts of craftsmanship upon which works of art of the highest order were conceived and performed.[17] Trevor Pinch and Frank Trocco's *Analog Days* is a valuable look at the history of the Moog synthesizer, informed by Pinch's training as a physicist, as well as his theoretical work into the user-oriented social construction of technology.[18] Pinch and Trocco's work will undergird my discussion of synthesizers and claviocentrism, and support my argument about the move toward MIDI's substitution for acoustic instrumentation. Paul Théberge's book *Any Sound You Can Imagine* is a finely tuned examination of the music instrument industry, containing analyses of electronic musical devices since MIDI's implementation, and their shifting locations within networks of interdependent music industries.[19] Above all, Théberge's work serves as the foundation for a great deal of my thinking on how MIDI was sold and consequently circulated through various marketplaces, studios, homes, schools, and the like. As a study of a non-standard standard of sorts, my work will make a contribution to the history of standards, as well as build upon Théberge's interrogation of music technologies, user groups, and democratization.[20]

An Overlapping History in Four Parts

To tell the story of MIDI, I have chosen a fourfold approach. First, we will look at a deep-historical timeline of keyboard instruments. Then, we shall discuss what was happening concurrently, in the more immediate time in and around MIDI's conception, both musically and technologically. Next, we will investigate the organizational and associational clusters that sprang up to steward MIDI into standardization. Finally, we will take a look at the industry's response to the explosion of MIDI instruments, and their attempt to rekindle some of the fire that the standard ignited in the musical instrument business. These sections follow a loose chronology, revealing MIDI's distinctive discursive trajectory, and the circulatory frequency of ideas and information. Chapter 1 introduces the concept of claviocentrism – the musical and cultural logic within which MIDI materialized. After the design of pianos stabilized in around 1850, the keyboard continued to be a central component of the musical ecosystem, and especially the music instrument industry. The establishment of the twelve-tone musical scale, equal temperament, and uniform intonation introduced the idea of musical notes as discrete values, and simultaneously excluded frequencies that fell outside the scale. The piano is, in fact, a music machine more than a stringed instrument – closer to a percussive instrument that plays harmonically than, say, a guitar or violin. The keyboard triggers a set of events that produces a sound, and keyboard instruments have a different kind of non-analogous expressive character because of these mechanistic procedures.

Music pedagogy contributed to the view of music's national character, and the push toward a distinctly American musical tradition helped distance US and British culture after the War of Independence. In the US and the UK, piano companies and retailers initiated what we might consider today to be predatory lending practices, with hire purchases becoming more and more commonplace. And in the early 20th century, pianos proliferated. Coupled with a number of manufacturers producing cheap and shoddy instruments, the rash of pianos entering the homes and parlors of more and more people was viewed by some as a blight on the virtues of high music culture rather than a leveling force bringing musical instruments to the less fortunate. Even though more people with less advantage could afford musical instruments, music education and lessons were generally a privilege of the wealthy. The piano radically shaped the musical instrument industry into which MIDI emerged at the end of the century.

MIDI was equally dependent upon a history of musical automation, beginning with the mechanical clocks of the 13th century, and moving through the music boxes, metronomes, and player pianos that followed. Musical automata both prescribed and replaced elements of musical performance, and the standardization of piano rolls at the turn of the 1900s had much in common with the standardization of MIDI nearly a century later. Regulation of music instrument manufacture was also the impetus behind the formation of trade organizations like the National Piano Manufacturers Association of America and the National Association of Piano Dealers – forerunners to NAMM. Music making machines reflected the increasing mechanization of modern life, and also contributed to the de-skilling of musical capability. The advent of player pianos highlights the dichotomy between music as labor vs. music as leisure, and sheds light on the movement towards music producers as consumers of music technology.

Beginning in the 1930s, mechanical and electronic innovations led to the rise of home organs, and a spate of recordings helped to popularize the sounds of various brands and models – particularly the Hammond. Early synthesizers made by Moog and ARP incorporated the keyboard into their design, capitalizing in part on the electric organ's popularity. Integrating a keyboard into their instruments made them more accessible to the majority of musicians who were familiar with the piano's layout, and subsequently more successful in the marketplace. Roland

Corporation – one of the two most influential companies involved in stimulating the MIDI standard – was built in large part on the strength of its organ manufacturing, as well as the early automation of electronic rhythm and percussion instruments.

Music education took a turn towards the technical, post-MIDI. As with the flurry of inexpensive pianos at the turn of the 20^{th} century, MIDI-capable instruments were marketed by their manufacturers and the industry at large as having a profound democratizing effect on musical instruction in the classroom. In fact, MIDI often further divided music classes, most notably along gender lines, and attenuated the processes of learning to play instruments in socially negotiated settings. I claim that, by bringing all sorts of sounds under the control of a single keyboard device, MIDI encouraged playing music alone. The advent of MIDI further shifted ideas of musical skill away from the sustained and dedicated practice involved in learning to play a traditional instrument, and toward savvy with digital instruments like synthesizers and computers.

In Chapter 2, we will explore some of the advancements in music technology that immediately presaged MIDI, and consider some of the musicians, and their music, which necessitated the kinds of machinic control that MIDI was designed to satisfy. We will hear personal accounts of Progressive Rock musicians Rick Wakeman and Keith Emerson, Jazz artists Herbie Hancock and Don Lewis, instrument designers Bryan Bell, Tom Oberheim and Dave Rossum, and sound designers John Chowning, John Bowen, Jack Hotop, and Jerry Kovarsky. The kinds of music that Emerson, Wakeman, Hancock, and Lewis were creating during the 1970s were largely the inspiration behind the development of the MIDI specification.

Hancock and Bryan Bell conceived and built systems for triggering multiple instruments simultaneously, and automating the processes of the entire studio, several years before MIDI was under discussion.

Likewise, Tom Oberheim had developed a computer sequencer, and was among the first to develop a polyphonic synthesizer – that is, one capable of playing more than one note simultaneously. Under the direction of founding engineer Dave Rossum, E-mu Systems had developed the patent for Oberheim's polyphonic keyboard, and was designing E-mu's own microprocessor-controlled synthesizer instrument. E-mu built a sequencer designed to work between an IBM PC and its Emulator sampling keyboard several years prior to MIDI. But, like Oberheim's system, these early attempts at interfacing instruments were entirely proprietary: they did not function between instruments of different manufacture.

In the mid-1980s, Don Lewis, the inventor of a multi-keyboard instrument called LEO, found himself in legal hot water with the American Federation of Musicians – a phenomenon that dogged early adopters of digital synthesis and MIDI technologies. With the increase in use of microprocessors, synthesizers started to come loaded with uniform preset sounds, which would become the signatures of individual instruments, and the musicians who used them. Sequential Circuits' Prophet 5, in particular, set a precedent in the synthesizer business for a machine that could manipulate and store preset voices. John Chowning's development of FM synthesis at Stanford University in the 1970s led to the programming of realistic emulations of acoustic instruments in the Yamaha DX7, an instrument whose production would coincide with the release of MIDI in 1983. Subsequent synthesizers took the trend further by incorporating digital samples of real instruments in their presets. Ultimately, MIDI-linked instruments troubled the authorship and authenticity of synthesized sounds, brought entire orchestras under central control, and contributed to the aesthetic homogenization of electronic music throughout the 1980s and 90s.

Chapter 3 is dedicated to a discussion of the standardization process, and how MIDI both fit into and resisted other models of technical regulation. Here, we will consider the agency exerted by standards, as well as the standardizing force of the actants and human actors embedded in associational and professional networks and organizations. New standards necessitate new ways of doing things – new modes of operation. Standards are essential to making things work together, over distances, and across time. MIDI was no different. It ushered in "new normal" circumstances and, once embedded, built a significant amount of inertia within musical instrument design and the music produced with new MIDI-ready devices. While all technologies may be socially constructed, MIDI was arguably even more so in the absence of any authoritative regulatory body. But other guardians of MIDI stepped in to shepherd the development and adoption of the specification.

Doubtless, NAMM was the most important organization to MIDI's evolution: it was first demonstrated at a NAMM convention, and the organization provided the field upon which discussions and discourse around MIDI took place. NAMM was at once a space for open and collaborative dialogue, as well as an uneven site for the closing off of negotiation and the performative process of decision-making. There was a considerable rift, too, between American and Japanese instrument makers:

Americans were in the process of differentiating themselves in the marketplace, and Japanese manufacturers were thinking more collectively. There was no real consensus amongst American participants about what MIDI should be or do, but the weight of the Japanese manufactures' involvement lent the project its critical mass. In Japan, the Japanese Electronic Music Instrument Association and the Japan MIDI Standards Committee assumed authoritative roles. In the US, the MIDI Manufacturer's Association and the International MIDI Association dueled in part to steer MIDI through the process of implementation, and also in part to maneuver themselves into positions of influence in the electronics and music industries.

There were varying ideas about what could and should be done with MIDI, and a series of miscommunications arose between manufacturers, and among instrument makers, associations, and early adopters of MIDI technology. Different manufacturers had slightly different methods of implementing the specification into their devices, which translated into cascading interfacing problems. For a standard, MIDI might not have been standard enough. Nonetheless, MIDI was adopted overwhelmingly quickly and universally, and found its way into the studios of professional musicians, into the halls of international academic institutions, and into the homes of millions of amateurs. New publications and user groups sprang up to discuss and debate MIDI and its surrounding technologies. Still, users likely contributed less to the creation of MIDI than they did to its success, as sales of MIDI-related gear soared throughout the 1980s.

In Chapter 4, we will turn our attention towards a smattering of industry responses to the overwhelming success of MIDI, and its attempts to keep sales and profits rolling for as long as possible. In large part because of MIDI, the digital instrument industry began increasingly revolving around personal computers in the 1990s, and innovations being made in hardware and software were mutually driving developments in musical instrument design, and the kinds of products that came into the marketplace. In a way, MIDI's dream of universal interoperability stifled the sorts of product turnover and obsolescence that drove business in other forms of consumer electronics. Despite its popularity, MIDI had other problems to face, like mounting resistance from frustrated users.

In its short lifespan, MIDI accumulated a sizeable amount of lingo that confused not only potential buyers, but also the dealers trying to sell them equipment. MIDI was impenetrable to the uninitiated. NAMM sponsored a number of surveys – of MIDI retailers and computer musicians – trying to pinpoint potential markets and strategize their targeting, but first they had to help manufacturers and merchants educate consumers about the benefits of using MIDI. In response, NAMM initiated a campaign not unlike the early 20th century sales of player pianos and home organs, touting MIDI's ease, equating it to a "language," and naturalizing it in the minds of the computer literate and technologically unskilled alike. Manufacturers also reacted by creating and adopting General MIDI, a simplified and streamlined version of the specification housed within a new class of instruments designed for the most neophyte of users.

As digital technologies advanced further, and hardware and memory became cheaper and faster, a split developed between MIDI and digital audio, threatening MIDI's exclusive claim to the "tapeless" recording studio. Computers were no longer being used to simply control sound generating instruments; they were doing the generating and signal processing themselves, internally, making MIDI unnecessary for a range of musical applications. The musical instrument industry shifted towards computers and their users, believing that non-musicians might become compelled to make music with their PCs, if it seemed easy enough. Again, NAMM did a significant amount of market research, determining that they had to target predominantly white, well-educated, upper-middle class men. Music instrument manufacturers worked hard at cultivating new users for their products, and NAMM and the MMA conceived of a replacement specification for MIDI, but they never quite recaptured the extraordinary success of the original iteration – the version still today considered the industry standard for interfacing digital instruments.

I hope that this investigation of MIDI contributes positively to the body of literature around musical instruments, technical standards, and electronic music, and bridges the fields of music technology and communication studies, more broadly. With this dissertation, I aim to problematize the standardization process, and investigate whether officiating regulatory bodies are too demanding, whether the MIDI consortium was playing too fast and loose with the rules, or whether the truth was somewhere in between. Without question, some of my favorite music was made with the assistance of MIDI, and while my duties here are primarily to shed a critical eye on this part of cultural history, the energy behind this dissertation stems from an affinity for the people involved in creating and playing musical instruments, and the profound love of their collective work.

Chapter 1: Claviocentric Rings

When you hear a hot trombone,
Who's the power behind the moan?
It's the lady who swings the band!

When you hear the saxes ride,
Who's the reason why they glide?
It's the lady who swings the band![21]

The lyric quoted above is taken from a Decca label recording made in 1936 by Andy Kirk and His Twelve Clouds of Joy. Written by the prolific duo of Sammy Cahn and Saul Chaplin, "The Lady who Swings the Band" is a novelty piece about "a pretty gal named Mary Lou," a young pianist who "plays the piano in a manner that is ultra-new!"[22] In its final verse, vocalist Harry Mills inquires: "Who makes dancers on the floor / Beat their feet and yell for more? / It's the lady who swings the band!"[23] Indeed, Mary Lou Williams, the orchestra's piano player and principle arranger, contributed immensely to the band's musical sound and identity. Yet, keyboard instruments had been at the heart of Western music making traditions and new technologies since the 1300s.

Across the past three centuries, pianos have gradually and incrementally become the instrumental tail that "swings the band." In an era when large orchestras like Kirk's Twelve Clouds were making popular music with big horn sections and prominent percussion, the song foregrounds the piano's enduring significance to modern musical practices well into the 20th century. Throughout this chapter, we will note too how the lyric is relevant when it is recontextualized into the recent history of electronic music and its technological developments, which ultimately led the keyboard synthesizer to swing *every* instrument.

Cultures of Claviocentrism

The keyboard and electronic synthesizer industries of the 1970s and early ‘80s were central to bringing MIDI about, primarily as a means for their markets to consolidate and grow. But the MIDI business would not have existed if not for what I shall describe as a culture of claviocentrism in Western music making traditions, dating back hundreds of years. By claviocentrism, I mean the centrality and predominance of the clavier keyboard and its peripheral instruments – primarily the piano, but also the clavichord, harpsichords, pipe and electric organs, accordions, keytars, and any other musical instrument that makes use of an ebony-and-ivory-style manual keyboard. This is echoed by Paul Théberge, who asserts: "… the category of keyboard instruments, today including not only pianos but also organs, synthesizers, digital pianos, and portable keyboards, has consistently dominated the music instrument trade."[24] These instruments have existed in assorted forms since the fourteenth century, and their design remained relatively constant after the 1850s.

Claviocentrism describes the cultural-historical condition, the musical cultural logic, within which MIDI (along with a host of other music-making devices) was conceived. The piano was also vital to institutional and private music education. I shall use the term to refer to the piano scale and equal temperament also: the subdivision of frequencies into twelve discrete and tempered correct tones, to which the vast majority of music is tuned. For over a century, the physical structure of the piano, and the harmonic structure of its scale, has subsequently been imbedded into every new musical technological innovation. Claviocentrism furthermore characterizes the process by which other musical instruments and devices tended to cluster around, be swung, or "slave" to the keyboard. The ubiquity of the clavier keyboard is an often-neglected and taken-for-granted phenomenon of Western music. Here, the "Clavis," from the Latin meaning "key," shall offer us both literal and rhetorical keys to deciphering the language of keyboard-made music, and by extension, MIDI.

Since it was introduced in church organs around A.D. 1000, the clavier keyboard has become the focal point at the center of an expanding constellation of sound-producing technologies.[25] The standardization of each subsequent piece of claviocentric technology further embedded the piano keyboard into the processes and social fabrics of music making, and influenced how composers and listeners imagined musical compositions. Along with the advent of the keyboard (and even more so with its eventual mechanization) musical notation became more and more prescriptive in tandem with technological developments like metronomes, and various forms of automation. Like MIDI, musical automata were greeted as novelties in their own time, and gradually became entrenched into a larger musical culture centered on the piano. To understand that culture, and the historical context within which MIDI arose, these and other claviocentric technological benchmarks will be the focus of this chapter. An investigation into the processes by which claviocentrism flourished will reveal its aesthetic and technological significance and consequences.

The Tuning of the World

In her 1986 book *The Seventh Dragon*, scholar and piano tuner Anita Sullivan offers a detailed and poetic account of how different methods of tuning pianos were established, and how "equal temperament" won out over others. Pianos generally have 88 keys, each corresponding to a string or series of strings stretched along a soundboard. But each note is in tune only in relation to the intervals between each of the other notes. Sullivan writes: "the notes didn't come into existence in the order we see them on the keyboard, but rather because each of them is 'three-to-twoing' or 'five-to-fouring' or 'four-to-threeing' with its consonant partner several steps away."[26] She continues:

> We hear best and most happily (in the West, at least) when our adjacent notes have an established territory. Each note must be a whole in itself, it cannot trail bits and pieces of the one behind. Our music does not slide (not yet, not yet); it makes quantum jumps. The space between notes remains silent.[27]

In a sense, the musical space that exists between whole notes was both produced and destroyed by the clavier keyboard's establishment and adoption of the twelve-tone scale. The microtones amid pure frequencies and intervals were simultaneously created and effectively erased in the historical shift towards claviocentrism. The clavier keyboard subdivided the audible continuous frequency spectrum into a series of discrete notes. Sullivan contends: ""Ironically, the piano, whose massive size and many notes have made it the most inflexible of all instruments in the world to tune, has become the intonational dictator for the entire world of music."[28]

Despite being comprised of strings, the piano does not resemble other kinds of stringed instruments, like those that are strummed, plucked, or played by a bow. They are, rather, complex music-making machines whose keys *trigger* interior mechanisms – hammers, dampers, coils, springs, and buttons – that actually accomplish the instrument's sounding.[29] The piano is shaped more by an on-off binary logic rather than of expressivity. And those on's and off's are tuned melodically rather than percussively. There is a series of intricate operations that must occur between the human hand depressing a piano key and the note that results. How that note sounds – its pitch; how loud or soft; of long or short duration – depends upon how the player plays it, but those variations are nonetheless translated through the instrument's internal technics. And so, claviocentrism furthermore speaks historically, of the mechanical, technological, and communicative process of making music with keyboard instruments, a paradigm that would remain constant throughout the 20th century and contribute critically to MIDI's development.

Since the 1300s, new keyboard instruments and innovations developed in tandem with the music that was created with and for them. By enabling different modes of performance between them, each instrument encouraged distinct ways of playing, and produced its own set of characteristic timbral qualities. The harpsichord's mechanism, for example, uses a system that plucks its strings with a guitar pick-like jack called a plectrum, which does not allow for variations in velocity, pressure, or after touch. Each note is plucked at the same volume and tone, regardless of how hard or softly the key is depressed. Clavichords use hammers similar to the piano, which do strike its strings at varying velocity, but because of its smaller soundboard and overall construction, their sound cannot achieve the loudness of a harpsichord or piano. Consequently, Clavichords were used more in chamber settings, or for solo practice purposes.

The Clavichord was preceded by the Clavicytherium, which Belgian musicologist François-Joseph Fétis believed was probably invented in Italy in around 1300, and later updated by both Italian and German instrument makers.[30] The Clavicytherium also employed plectra made of quill, and a triangular formation of strings fashioned from catgut. Depressing a key would pluck the corresponding string at the same intensity, no matter how hard or softly it was played. Some later models of harpsichords included two or more sets of strings playable from the single keyboard, which would usually be tuned in octaves, producing a doubling of frequencies – in effect, playing two instruments at once. In its conception, MIDI was more akin to a Clavicytherium or Harpsichord than to a piano: like the plucking plectra, there was only the most basic note-on / note-off information being communicated. Still, as velocity sensitivity and after touch became more integral to contemporary keyboard synthesizers, MIDI's continuous controllers began emulating characteristics of other kinds of instruments beyond the keyboard.

The Piano Business

Until the 1860s, pianos were still predominantly the terrain of the affluent, but a convergence of events shortly thereafter would make them less expensive and more attractive to everyday buyers. In England, average wages were increasing, and expensive import tariffs on raw materials were repealed, stimulating enthusiastic piano buying. At the same time, local production was expanding, and after generations of piano manufacture throughout Europe, a significant second-hand market emerged as well.

Because pianos were more costly than, say, violins, hire purchase, colloquially called the "Three Years System," became common after the 1880s, with buyers putting small deposits down and paying the rest off in monthly or quarterly installments. East London firm Moore & Moore, and Archibald Ramsden of Leeds are often equally regarded as the originators of pianos for hire, a practice that would bring keyboard instruments into the homes of more and more working class people, and also finagle those same people into often ruinous financial obligations. To further stimulate sales to those with the lowest income, deposits were eventually done away with altogether; historian David Russell notes: "By 1900, no deposit and 10*s* a month payments over three years were common."[31]

In an 1881 treatise entitled *Phases of Musical England*, historian Frederick Crowest criticized the "Three Years System" for a variety of reasons – not so much for the usurious practices of instrument dealers, but more for the ubiquitous cacophonous and out-of-tune clanging that must have accompanied such a piano buying craze. Bringing music to the underclasses was considered less a gift to them than a curse to proper musical taste and tradition. In one fell swoop, Crowest harpoons the greed of unscrupulous merchants, gullible buyers, shoddy manufacturers, unskilled players, hopelessly discordant instruments, and the entire system of wage labour that enabled such a state:

> It is not the extracting of money from the pockets of those who can ill afford to lose it, the offering of apparently astounding – but illusory – liberality, or the over-charging of which complaint can best be made, since the remedy for such practices rests with the public, who have themselves to blame if they make such foolish bargains; but it is the flooding of the market with inferior instruments, the vamping up of this staff of our musical life, the gluing together of unseasoned woods and common materials under a system of labour that can guarantee nothing but inferior workmanship, and the carrying of false harmonics and untrue chords and intervals into the homes of hundreds of thousands of families." [32]

Obviously, simply owning a piano – or even being able to afford one – did not equate with being able to produce something like music with it. Private lessons were prohibitively expensive for many, and public schools did not generally possess the economic resources necessary for widespread piano tutelage. Citing a study done on early English state school music education, Russell notes: "While children of the lower middle and upper working classes … might find instrumental tuition a possibility, the poorest were excluded."[33] Russell continues: "It is significant that school music was at its strongest in those areas which already possessed a highly developed musical culture."[34]

In the US, however, music education took a decidedly more patriotic turn. As waves of immigrants arrived from across the Atlantic, their instruments and folk musical traditions came too; in addition to other kinds of culturally specific quotidian life, the New World was also a melting pot for international music cultures. Following the Revolutionary War, a cultural backlash spread against all things British, including its music, which was viewed as another old hegemonic force to be done away with.[35] Yet, the urban upper classes were wary of the acculturation of more traditional European and international folk musics. Musicologist Charles Seeger notes that, in the period after 1830, a concerted though loosely organized effort was made by "a small vanguard of private citizens" to "make America musical" – to construct and assert a specific national character through a systematic remapping of the contemporary musical landscape.[36] These efforts took two directions: the creation of American ensembles, choirs, and orchestras; and the zealous promotion of musical education in public schools.[37] But by the early 1900s, with the advent of automation and mechanization across broad segments of a newly industrialized America, investing the effort and dedication necessary to master an instrument was becoming a quaint and almost frivolous notion.

Musical Automata

At the turn of the 20th century, player pianos were fast entering the American marketplace, and bypassing the need for acquiring time-consuming and expensive musical skill. Before the gramophone, radio, and recorded music, player pianos were a popular way for those who did not play an instrument to have music at home. But musical instrument automation has a lengthy history prior to the Pianola, and self-playing instruments once possessed a more sacred and wonderful kind of aura in the common imagination. The automation of music making strikes a deeper chord when considered in the context of a social spectrum where machines of all sorts assumed a more and more agentic role in daily life.

Jesuit mathematician Athanasius Kircher included a plate depicting schematics for a self-playing organ, which he also later built, in his *Musurgia universalis* of 1650.[38] A standout piece in his museum that included all manner of curios, from fossils to mechanical and hydraulic clocks, Kircher's "acoustic musical theatre" was designed to display the wonders of natural magic, and the harmonic perfection of God's universe.[39] The diagram plate depicts a keyboard and pipe organ operated by a horizontal water-driven perforated tin foil cylinder below, triggering the correct keys as it rolls along. Figure II portrays blacksmiths hammering at a forge, in reference to the smiths that apparently inspired Pythagoras to theorize music in harmonic intervals. The illustration also features a scene of purgatory, with souls dancing in a circle at the foot of a human skeleton. In the functioning museum piece, miniature scenes like these were automated to accompany the organ, and "moved in time to the music like film sequences."[40]

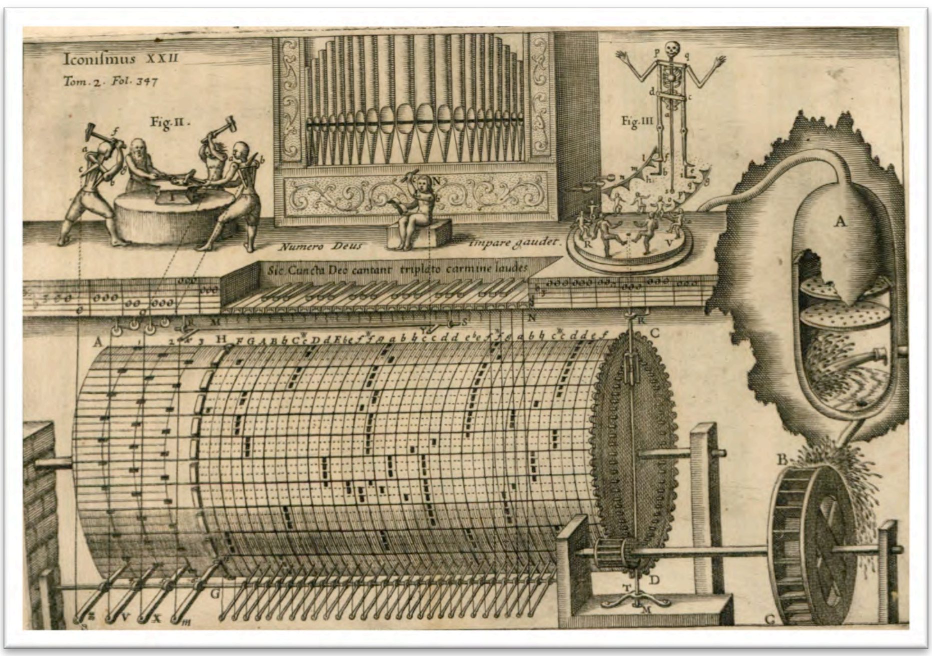


Figure 2: Organ from Kircher's "Musurgia universalis," 1650.

Kircher's design was based on a water-powered motor, but the plan for player pianos owes more to the development of mechanical clockwork, and the clockwork-ness of machines, more broadly. The clock-driven bell towers of the 14th century European monastery, which tolled upon the canonical hours of prayer, were in fact both automatic and musical: the world's first mechanical clocks were also self-playing musical instruments. F.J. Britten's 1904 *Old Clocks and Watches and their Makers* contains an entry on a British musical clock made sometime before 1736, by Charles Clay of London. Britten cites an extract from the *Weekly Journal* dated May 8th of that year, describing an event in which Clay "had the honour of exhibiting to her Majesty at Kensington his surprising musical clock, which gave uncommon satisfaction to all the Royal Family present."[41]

Music, modernity, machinery, and time are intertwined. As Lewis Mumford writes in *Technics and Civilization*, "The clock, not the steam-engine, is the key-machine of the modern industrial age."[42] He continues: "[The clock] marks a perfection toward which other machines aspire [and] serves as a model for many other kinds of mechanical works…"[43] Ironically, by abstracting and dividing God's eternal time, the pastoral and cyclical time of nature, the seasons, and revolutions, the clock "helped create the belief in an independent world of mathematically measurable sequences: the special world of science."[44]

Because music also relies upon that special scientific world, the world of mathematically measurable sequences – time – methods of synchronization were crucial to the functioning of mechanical organs like Kircher's, and others that followed. Although hand-cranked barrel organs were popular in the 18th century – London manufacturer Benjamin Flight introduced the church version sometime prior to the 1770s – they required a steady hand to turn out the tunes at the right speed.[45] Kircher's water model provided continuous motion, but slight variations in the timing of a human source of barrel rotation would result in the speeding up and slowing down of musical pieces – an awkward musical motion akin to the jittery imagery of early hand-cranked films. Between 1720 and 1820, Viennese clockwork organs proliferated, some achieving high musical standards and quality.[46] In the late 1700s, James Watt designed the ball governor to regulate the speed of steam engines – an innovation that facilitated the continuous motion of machine parts.[47] Keyboard instrument historian Arthur W.J.G. Ord-Hume writes in his 2007 book *Automatic Organs*: "…it is easy to imagine that the early makers, seeking a reliable means of powering their 'self-acting' instruments, turned to clockwork as the modern driving force for the mechanical organ."[48]

The Metronome

Mumford characterizes mechanical clocks as the first and foremost machines to affect the development of the Western world, from keeping the medieval church running on time to setting the pace of modernity; from regulating the hours of prayer to synchronizing the seconds of daily life. The musical metronome, emerging in the 18th century and widespread by the 19th, similarly regulated the rhythm of music practice, which led to music performance. Sustained investigation into the integration of music with machines reveals a tension between creative control and freedom that was already apparent after the introduction of the metronome, and continues in discussions around MIDI today.

Earliest examples of mass-produced metronomic models were manufactured mostly by well-known clockmakers, and marketed as "musical time-beaters."[49] When the metronome was introduced into the marketplace, it had a profound effect upon the way music was conceived of and played. Metronomes enabled a more precise decoding or translation – from the music's composition to its performance – of tempi and cadence. By the 19th century, music began to be thought of in terms of beats per minute, to be played back in time; gradually, works became less subject to temporal interpretation or rhythmic flux.

Prior to the mechanical recording of sound, professional composers and amateur musicians traded and made their living through selling printed scores of works to other players, ensembles, and orchestras to perform. Those scores might have been marked with instructions on time signature, loudness, tempo, and other manners of playing that call for mention. Once metronomes hit the scene, however, more regulated tempi became common, especially upon the works of the period's most celebrated composers: Beethoven and Mendelssohn would have been considered early adopters of the musical time-beater. But the fledgling metronome was initially intended to measure the pace of the composer's preference for the performance's speed, not to set it. The metronome was supposed to be less a prescriber of tempo than it was a time-marking machine.

But users adopted it differently. Until weeks before his death, Beethoven was still hard at work dispatching letters specifying metronome marks and other playback cues on his ninth and final symphony.[50] Conversely, Hungarian composer Franz Liszt purposely marked many of his scores "sans ton ni mesure," without key or time signature, anticipating players who might favor different tempos or instrumentations in their interpretive performances.[51] Étienne Loulié, creator of the late 17th century "Chronomètre," preferred to measure music's beat by a "healthy man's heart rate."[52] In the 20th century, the click track in media production more generally represents the link between metronomic composition and the rhythmically rigid conception of MIDI. The advent of the metronome marks a significant turn towards *playing along* to machines, a discourse that continues currently around electronic music production, DJing, the incorporation of MIDI technologies, computers music, video games, and questions around "live" performance.[53]

Gather 'Round the Piano(la)

On the surface, the basic conceptualization behind the Pianola – to automatically and autonomously control a piano; to communicate note on and note off commands; to keep tempo to an internal regulated clock – is analogous to the way MIDI sequences were imagined to operate 100 years later. Until electric models arrived in the 1930s, organs were largely relegated to churches, theatres, and the street. But from the turn of the century onward, player pianos took over the homes of millions, and provided the soundtrack for America during the Progressive Era, their efficient anempathetic clunking as ever-present as industrial machines themselves. During the mid-1800s, various prototypes sprang up in France and Scotland, modeled after the Jacquard loom, a punch card system designed for weaving elaborate patterns into silk. Perforated cylinders of scrolled cardboard could unravel within a spinning device that, instead of moving a needle, would perfectly "play" the keys of a piano, with mechanical "fingers." Different scrolls of cardboard could be perforated with different patterns, capable of playing various pieces of music. Parisian automaton maker Fourneaux's "Pianista" model sold modestly after its exhibition at the Philadelphia exposition of 1876.[54]

In the US, Theodore Brown of Worcester, Massachusetts, was one of the four most important figures in the player piano marketplace; his Simplex Player Piano Company manufactured among the best selling instruments.[55] The Simplex was a 65-note player with a three-spring clockwork motor.[56] However, Melville Clark of Oneida County, New York, would prove the most influential individual in the development of player pianos. Clark was trained as a piano tuner's apprentice, and started his own reed organ company in California, before settling in DeKalb, Illinois.[57] In 1900, he established the Melville Clark Piano Company, manufacturing the Apollo Concert Grand Player Piano – the first 88-note player, patented one year prior.[58]

Here, a problem arises: if Simplex makes a 65-note player, and Clark makes an 88-note model, how will rolls designed for Clark's Apollo play on a Simplex instrument? The short answer is, they will not; and so, in 1905, the four major player piano manufacturers joined together to create a uniform roll, which would become standard and contribute immensely to the marketplace success of the Pianola.[59] The standardized piano roll was itself a cascading standard based upon the typical piano keyboard layout, and set within the cultural logic of claviocentrism. MIDI was also standardized in much the same way: by a consortium of keyboard instrument manufacturers looking to regulate and corner their own business. These instances of standardization allowed for the widespread mass production and interchangeability of musical instruments and parts. Théberge writes: "Industrial co-operation and standardization thus proved to be essential components in a strategy to both stabilize and stimulate the marketplace."[60] At the height of their popularity, 58% of pianos bought and sold internationally were players.[61] As another form of recorded music, piano scrolls served as musical notation much like printed scores – archival documents of how key musical pieces were supposed to be played, heard, under what circumstances, and how those assumptions shifted over time along with the introduction of multifarious technologies.

With its regulation and fast adoption, the automatic roll model for notational playback was even adapted by other kinds of musical instruments, like the ill-fated Rolmonica endorsed by a young Joan Crawford between the late 1920s and early 30s (see figure 3). These devices were situated at an important historical interstice, between the ending of the mechanical and pneumatic era, and on the cusp of the massive influx of musical instruments as leisure-oriented technologies. But the similarities to MIDI are more striking when considering the rapid consolidation of corporate power taking place in America at that time.

Tricks of the Trade

Foreshadowing the events surrounding MIDI's standardization, which we shall discuss in greater detail in Chapter 3, it was once again the manufacturers who initiated a process of self-regulation, under the auspices of both loose and formalized professional associations, with the ultimate goal of at once corralling and expanding the industry for everyone involved – and too bad for those who were not. In the autumn of 1890, several New York-based manufacturers formed the first officially recognized organization for piano makers, electing William E. Wheelock of the Wheelock Piano Company as its first president.[62] Amalgamating along with a handful of retailers and other local associations, the National Piano Manufacturer's Association of America was formalized in August of 1897.[63] Dolge notes of the guild's founding principles, the wording of which rings equally with capitalist and populist rhetoric: "Its object is the furtherance of:

> (1) A better acquaintance among the members of the trade, good fellowship and interchange of views of mutual concern.
> (2) The ethics of the piano trade.
> (3) Territorial rights of manufacturers and dealers in regard to selling pianos.
> (4) A uniform warranty.
> (5) The products of supply houses: i.e., the question of stamping the manufacturer's name on piano parts furnished by the supply houses to the trade.
> (6) The relation of the manufacturers to the music-trade press.
> (7 & 8) To obtain reductions in insurance and transportation rates.
> (9) The establishment of a bureau of credits.
> (10) Legislation by united action; that more uniform laws shall be enacted in several States regarding conditional sales, and such other matters of importance to the piano trade as may come up from time to time.[64]

These principles emphasize the fraternal nature of doing business together in America at the turn of the 20th century. In the spring of 1902, the National Association of Piano Dealers of America was founded, expressly to oversee the "ethics" part of the manufacturer's principles, and above all, to stimulate the "mutual elevation of trade interests."[65] Arguably, however, the ethics of trade are often not best left to those with the most to gain from transgressing them. Nonetheless, the guild's principles encouraged a kind of honor system of adherence. They subsequently carved up the nation into territories, much like a mafia family might carve up segments of a city amongst its captains. They controlled the manufacture of not only the instruments themselves, but also the parts the instruments were made from. And with their collective weight, they leaned on other industries – shipping, indemnity – to lobby for cut rates and discounts. From its beginnings, the association was closed to the general public, with associate rather than active membership status being assigned to those who did not qualify as retailers. By 1911, the dealer's association represented 1000 paying members, and inaugurated annual conventions designed to introduce manufacturers and retailers, and display new products to potential distributors. This association would become NAMM, and its annual meetings ballooned into the mammoth trade shows under sprawling convention centers that NAMM Shows are now known for – an international house of handshakes dedicated to selling innovation in the music industry.

The social context within which the piano and player piano industries' rapid expansion of took place, along with the quick consolidation of manufacturer and retailer interests, reveals a turn-of-the-century culture obsessed with modernist ideologies of speed, efficiency, technological progress, democracy, and most of all, capitalism. Piano manufacturers realized that they could produce more instruments faster and more uniformly, reduce their operating costs, and make more money by acting as a single unit rather than a series of competitors. The creation of national associations may have ostensibly taken place under the auspices of better and more affordable instruments, or the promotion of music education to those who might not otherwise have access to it, but the formation of self-regulatory organizations – like, for example, the Motion Picture Producer's Association of America – were also pre-emptive moves on the part of industry at large to keep legal or governmental regulation at bay, and of course to lobby those bodies in their own favor.

Never Had One Lesson!: The Effortlessness of Technology

The buy now-pay later mentality would enter in a big way into other forms of consumer durable purchasing in America, from sewing machines to iceboxes to automobiles, and later, to phonographs, radios, and other audio-visual electronics, home computers, and eventually, MIDI-capable devices. It is fair to argue that, along with these other examples, the Three Years System in England effectively created the conditions for the modern credit system's proliferation in America, enabling banks and private intermediary companies to reap massive profits from the impatient demands of new classes of consumers. Those buying player pianos were not particularly interested in investing time and effort to acquire musical skill; but they would invest real money into an instrument that did not require any skill at all. The rise of player pianos indicates an early shift toward broad musical de-skilling – or re-skilling – that would carry on well into the 21st century.[66] It is easier to let the instrument play itself than have to do the playing. The copy beneath an early advertisement for the Rolmonica boasts: "Never took a lesson in my life!"

Figure 3: The Rolmonica on display at the Museum of Making Music, Carlsbad CA, March 2014.

Pianos were marketed by companies like Steinway and Sons as objects of high-cultural consumption, associated with affluent lifestyles, and implicitly sold as vehicles for upward social mobility.[67] Paul Théberge contends that player pianos existed at the interstice of two competing American ideologies in rapid formation between 1880 and 1920: the do-it-yourself Protestant work ethic (labor), in which skill is acquired over time and at considerable expense; and the easy-as-123 appeal of technologically produced music (leisure), that in a sense makes those skills all the less desirable, and seemingly unnecessary. An early advertisement for the Pianola depicts a man, pipe in hand, arms folded, seated idly at the instrument in an idyllically soft-lit domestic interior. The copy reads: "Pianola – Helps Dad Relax."

Figure 4: Labor or leisure?

Simply, achievement could be achieved without the actual act of achieving. Théberge writes: "The personal sense of individual achievement and creativity characteristically associated with the 'producer ethic' of the nineteenth century and most clearly identified with the piano in middle-class Victorian culture was suddenly juxtaposed with an opposing set of values characteristic of the new 'mythology of consumerism' – effortless recreation, leisure, and immediate gratification."[68] The crossover between producers and consumers – music producers in many ways acting like consumers, with leisure time in rare cases being turned into a primary vocation as opposed to the idea of the musician as an artist, craftsperson, or master – problematized many historically held and culturally distinct notions around musical mastery and traditional relationships between musicians and their instruments.

Vital Organs

The home organ exploded in popularity following the introduction of the Hammond in 1935 – a "process innovation" which communication scholar Paul Théberge confidently describes as "the most important innovation in keyboard design during the first half of the twentieth century." [69] Théberge notes that the instrument amassed over 1400 orders in its first few weeks of production.[70] But despite its enormous appeal to amateur musicians, or possibly because of it, the Hammond organ is often disregarded or delegitimized in histories of electronic music. The distinctive sound colour of the B3, for instance, is among the most widely recognizable timbres of any keyboard instrument – think of Booker T. and the MGs' iconic riff from their 1962 hit "Green Onions," or Richard Wright's creeping organ Arabesque double-helixing around David Gilmore's guitar solo on Pink Floyd's "Careful With That Axe, Eugene," from 1971's *Relics*.

The Hammond was able to capture the imagination of a variety of musicians because of its distinctive sound, but also due to its transectorial marriage of mechanical and electronic technologies – technologies brought together from across different sectors of various industries. The organ was the result of a series of inventions and process innovations: the electric tone motor, vacuum-tube amplification, et al. It is worth stressing that Laurens Hammond, a clockmaker by trade, originally envisioned the rotating motor that generates the apparatus's tone to power his timepieces.[71] Into the 1960s and 70s, Hammond began incorporating other kinds of musical time keepers into its products; one of which, a rhythm machine manufactured under the name Rhythm Ace, was designed by a young Ikutaru Kakehashi, who would go on to found Roland Corporation in 1972, largely on the entropic strength of Hammond's home organ market.[72]

The widespread adoption of the Hammond spawned hundreds of instrumental recordings from specialty imprints, of concurrently popular and standard hits – recordings like *Brian Sharp Plays Mainly Hammond*, released on Grosvenor Records in 1973.[73] Interestingly, these records highlight the instrument right in their titles: the Baldwin, Lowrey, and Mighty Wurlitzer also featured in such similar kinds of recordings as Hal Vincent's virtuosic *Baldwin Soul* (which contains a truly unusual version of "Electric Chicken") released in 1971. Vincent's oddball kind of instrumental organ psychedelia found a home on cult Easy Listening stalwart Ad-Rhythm, the same label that stabled prolific British organist Harry Stoneham.

Between 1967 and 1980, Stoneham released over twenty records with titles like *High Powered Hammond*, *Hammond Heat Wave*, *Hammond Hits The Highway*, and *High, Wide, and Hammond* – usually featuring young, bikini-clad (or less) blondes on their covers, reclining on an outboard motor, or eating a strawberry –

including some original compositions, but mostly comprised of cover versions of everything from “Brazil” and “Stardust” to “Hey Jude” and “The Hustle.” (Stoneham also released a cycle of Lowrey Organ collections in the same vein on Ad-Rhythm.) The images on the records (see below) promise lifestyles: cool status, social mobility, and sex. Musically, they fall somewhere between what we might now consider Muzak and Karaoke, but I contend that they are early indicators of the desire by musicians and listeners alike for an automatable electronic instrument – as well as to be able to emulate the sounds of other kinds of instruments. The organ’s multiple preset voices and chords served as the model for swappable sound “patches” that would soon after become a crucial part of synthesizer design.

Figure 5: Assorted Harry Stoneham Album Covers

Arranged for Piano

Despite Hammond's commercial success in the home and on record, the instrument was still a long way from the emerging possibilities of electronic synthesis. Yet, the synthesizer business that Moog and others were constructing in America in the late 1960s and early 70s would prove heavily dependent upon a claviocentric mode of music making. Without a keyboard, synthesizers did not much resemble musical instruments. Trade in electric home organs had been consistently booming since the 1940s, and the shift toward manufacturing electronic keyboards capable of producing wider timbral varieties and more manipulable sounds took place as a result of the clavier interface's longstanding ubiquity. But the path was not necessarily predestined; it was more a path of least resistance, avoiding radical breaches in instrument design and performance technique at many key moments.

Electronic instruments could potentially take many forms other than a standard piano-type keyboard – and many did; knobs and patch cords dominated the initial interfaces of modular synthesizers. Indeed, some instrument designers coming from the avant-garde or academic world, like Don Buchla, for instance, were hesitant to adopt a keyboard interface at all.[74] Buchla's early refusal to adapt to keyboard controllers foreshadows his hesitancy years later with MIDI. In their book *Analog Days*, Trevor Pinch and Frank Trocco elaborate: "[Buchla considered] the keyboard a perfectly good way of doing what it does well, which is making polyphonic music based on a twelve-tone chromatic scale. It just never occurred to him that such a device was an appropriate way to control electronic sound."[75] To others, it did occur.

Bob Moog was rather market-savvy, having paid his own way through graduate school making custom-built Theremins and other kinds of electronics for musicians both inside and outside the academy.[76] Théberge writes: "Partly because of this [market] sensitivity and an interest in popular electronic organs, Moog, from the outset, had no reservations about creating an electronic instrument with a conventional organ keyboard as a controller."[77] Here, we can see that what may have seemed "natural" to some – Moog included – in an evolutionary view of musical instrument design, was actually the cumulative and skeuomorphistic result of complex and cascading conceptual forces set in motion long beforehand. The adoption of the clavier keyboard was a sort of impulse toward remediation. Moog capitalized on the home organ's popularity – and all the other claviocentric instruments that preceded it, but also made his instrument (the MiniMoog, released in 1970) that much more accessible to the average or amateur player, who might possess neither the musical skill nor technical expertise to approach a non-claviocentric electronic instrument straight out of the gate.

Kakehashi was especially keen on somehow fusing the simplicity of the Hammond with the timbral variation of something like a Moog synthesizer. In the mid 1970s, he met professionally with Moog, and ended up profoundly altering his own business as a result.[78] Following that meeting, Kakehashi became obsessed with synthesizers, foreseeing vast markets that the American companies had only begun to tap into, and imagining the production of new ones through innovation in digital instruments and technology at large.

Ikutaro Kakehashi and Roland Corporation

Pinch and Trocco's excellent history of Moog already exists, so I will not retell it here, other than for the purpose of stressing the reach and scope of claviocentrism into electronic instrument and synthesizer design. Less has been said, though, about Ikutaru Kakehashi, the founder of Roland Corporation, and co-recipient along with Dave Smith of the 2013 technical Grammy award for MIDI.[79] Roland was the principle company to stimulate the MIDI specification's development, along with Smith of Sequential Circuits working on the US side.

The NAMM Oral History program conducted two interviews with Kakehashi, once in 2001, and again in 2005.[80] One part oral history, one part carefully crafted advertisement for NAMM, the interviews reveal the extent to which Kakehashi influenced the business of electronic instruments, and shed light on how the Japanese keyboard manufacturers came to dominate the digital instrument industry. Kakehashi was born in Osaka in 1930. An only child, he was raised by his grandmother after his parents died suddenly in 1931. At an early age, he became fascinated with electronic devices, taking radios apart and putting them back together. While still a child, he contracted tuberculosis and spent four years in a sanitarium, where he read and studied English, but was unable to speak.

Music education was interrupted during WWII, so he was never formally trained to play an instrument, but organs would consume a large part of his imagination prior to starting Roland. Notably, Kakehashi's first business was a watch repair shop, where he began working during the war. In his shop, he also sold and serviced radios, and eventually built entirely electronic organs in his spare time.

As he recalls, he fell in love with the organ when he heard his brother-in-law demonstrate a Lowrey Organo church model in 1959. That instrument, which was designed to fit an organ inside a standard upright piano, required repairs from time to time, and Kakehashi agreed to fix it, in which time he was further educated on how to construct complicated keyboard machinery.[81]

Kakehashi's first instrument that he designed and built himself was a simple 49-key monophonic organ – he claims to have made the instrument so that even someone with no musical skill, like himself, could play it. He continued to study electronics on his own, and founded his first company, Ace Electronics, which began modestly by making a small rhythm box called the Acetone. Containing several pre-programmed settings for Waltz, Swing, Samba, and the like, the Acetone was designed to fit perfectly on top of a Hammond Organ. On his first trip stateside, Kakehashi demonstrated the product himself, with a single display table and a drape for a backdrop, in a Hilton hotel room at the 1964 NAMM show in Chicago. He sold eight units – one to each major organ manufacturer – but, by design, ended up developing a closer relationship with Hammond.

Figure 6: Ikutaro Kakehashi, 1964.

Soon afterward, Ace started importing organs into Japan, and Kakehashi became Hammond Japan, its official Asian subsidiary. Hammond saw potential in Kakehashi's self-taught engineering skill, and enlisted him into a top-secret development program for an "easy to play" organ. The result of "Project Mustang," as it was known internally, was the Hammond Piper Autochord – the first automatically chording instrument, which was released to commercial success in 1971. "Autochord" refers to the instrument's main innovation: the upper keys on the right hand side of the instrument play single notes, but the left hand side of the keyboard is dedicated to playing four or five harmonic notes at once, producing automatic bass chords when only one or two keys are played. The Piper is a significant innovation in a long history of keyboard instruments designed to be easy to learn, easy to play, and affordable to purchase. An early advertisement for the instrument is addressed: "To the girl who never finished her music lessons;" another, featuring Duke Ellington as a its spokesperson claims: "The Piper does a lot all by itself."

Figure 7: La dolce vita: Hammond Piper Advertising Campaigns.

Along with the Duke, Kakehashi had a great respect for musicians, and developed relationships with several notable keyboardists. He understood that for his instruments to be successful in the marketplace, professional musicians would have to want to play them – that they had to respect the style of performance musicians had already developed, but also offer something in the way of technological innovation. Kakehashi developed a friendship with Oscar Peterson, who apparently tested out his prototypes and encouraged him to continue developing keyboard instruments. He also met Don Lewis, who was playing a Hammond X77 with an Ace Rhythm machine at the time, through a NAMM-sponsored artist contract promotion. In 1977, Kakehashi saw Lewis perform on the LEO, or Live Electronic Orchestra, at the Hungry Tiger in San Francisco (more on this in Chapter 2). Surrounded by a half-dozen synthesizers, Lewis planted the seed for MIDI in Kakehashi's mind: pianos were always central to bands and orchestras, but they could not until then *be* bands and orchestras themselves.[82]

In 1971, Kakehashi took a sudden turn, leaving Ace Electronics, Hammond Japan, and a very profitable business behind. Infighting and apathy among the parent companies that had come to own Ace as a subsidiary greatly frustrated Kakehashi. He had effectively become a shareholder in his own company; there were too many competing interests as the corporation was sold and sold again. In 1972, he started Roland Corporation – with a two-syllable, easy-to-remember name, and a trademark R for a logo. Roland's first product was the TR77 Rhythm Box. And although the company would continue to expand in new directions, notably with its more guitar-oriented Boss subdivision, keyboards would remain central to Roland's business.

In 1973, Kakehashi introduced the SH1000, among Japan's first cheap monophonic commercially produced synthesizers. His goals with the instrument were simple: miniaturization and affordability. Kakehashi recalls that he got the idea of developing a synth from Moog, but wanted to make a single unit that contained a series of presets rather than something modular. Complicated modular systems like Moogs and ARPs were intimidating to novice players; simple keyboard instruments had accrued decades of public appeal from the organ trade, and advertising rhetoric of effortlessness. An early ad for the SH1000 boasts: "Easy to play … special effects at the touch of a finger."

Figure 8: The in-sound from far-out: Roland's SH-1000.

As Kakehashi saw it, the US synthesizer business of the early 1970s was mammoth competition, especially in the academic and professional markets. The US was already selling to musical institutes, and universities were more inclined to want Moogs than SH1000s. Kakehashi realized he needed to compete with the fairly developed US synth industry. He made a practice of always looking for partners – such as Ellington, Peterson, and Lewis – and having learned the lessons of the VHS vs. Betamax wars in the Japanese electronics industry of the late 1970s, saw the benefits of cooperation in research and development for the keyboard trade.[83] In 1981, Kakehashi discussed with Tom Oberheim the need for a universal interface, and the possibility of developing it together. But Oberheim was set on the idea of a parallel interface, in which both instruments could send and receive control information. An eternal pragmatist, Kakehashi believed that a serial interface would suffice, and keep costs down. Dave Smith of Sequential Circuits, however, had been working on just such a serial interface. Smith also shared Kakehashi's love of small synthesizers. And so, he was recruited to organize the US industry, with Roland rallying Korg, Kawai, and Yamaha behind the idea in Japan.

Despite the cheerful story of cooperation that often accompanies talk of MIDI, Kakehashi's business methods were shrewd. Rather than set up factories in countries with cheap labour and relaxed legislation, he believed it to be more profitable to set up shop right in the middle of his main markets, and he was right. In this way, factories rather than products could be distributed. In 1988, Roland acquired Rodgers Instruments from Steinway Musical Properties, to gain access to manufacturing in North America, and did the same thing in Europe with Seil, which became Roland Europe, based out of San Benedetto, Italy. As of 2005, Roland was based in 24 countries, with major manufacturing in Japan, Italy, Taiwan, the US, and Mainland China.[84]

In addition to musical professionals, Roland was attempting to expand its market into the elementary education sector, making instruments that could emulate other kinds of instruments. Really, any instrument could now be potentially played with a piano-type keyboard. This is the essence of claviocentrism: the ability to make any imaginable sound with a piano keyboard (more on this in Chapter 2). Still, beyond the keyboard interface, the definition of musical skill had to expand to include a high degree of technological literacy, too. As we shall see, contrary to NAMM's ongoing commitment to music education and putting instruments in classrooms, the advent of MIDI and other electronic and digital technologies served to gut schools of more expensive and difficult to play "pen and pencil" instruments, and segregate music classrooms – particularly along economic and gender lines.

MIDI-Capable: Music Education and Digital Technology

Literature on MIDI in music education is most frequently focused upon ideas of the efficiency, accuracy, and speed with which learning can be achieved with digital technology – ideas that do not typically reconcile well with the slow and deliberative pace of traditional music pedagogy.[85] Few studies exist that specifically target MIDI, and those that do shed light on how, beneath common assumptions that MIDI-capable musical instruments made music classes somehow more democratic, equal, accessible, and uniformly better, sharp borders were drawn around digital musical technologies. Larry Cuban's comprehensive 1986 study looks back at the history of technology in educational environments since the 1920s, recalling how technologies were welcomed as mechanisms for remediating and eventually replacing older forms (i.e. books with motion pictures).[86] To help explain MIDI to an overwhelmed public, Bob Moog published lengthy instructive notes on the specification in the 1986 proceedings for the Audio Engineers Society, following his participation in MIDI's introduction at NAMM in 1983.[87] Other press-release style pieces in teachers' publications – like Mueth's 1993 article "MIDI for the Scared to Death" – seem aimed by an instrument industry squarely at music educators, attempting to sell the technology's "substantial dividends" in the classroom.[88] Ajero's quantitative 2007 Ph.D. dissertation focuses on the effects of MIDI and other digital music technologies on the performance of piano students.[89] Kip Pegley's work is a comparative analysis of two groups of Canadian students and their implicitly classed and gendered interactions with technology.[90]

A key to selling MIDI-capable instruments in scholastic environments was developing the idea that keyboard technology could "democratize" the classroom by making music making more accessible to all. One premise of the democratization argument around MIDI technology says that new innovations enable more children to become musicians, and more musicians to make quality music, leveling the artistic playing field, lowering the bar of cost for musical tools, and allowing a more varied chorus of creative voices to be heard. Another predicate dictates that the increased consumption of consumer goods in general stimulates a more competitive marketplace, and leads to technological improvements and industry growth, with the cream of quality musical instruments and related products rising to the top. MIDI added a condition to the manufacture of a wide variety of digital instruments: be MIDI-capable or risk irrelevance in the then-rapidly-expanding digital musical instrument marketplace. The politics of standards reflects a clique-like mentality that was similar in the MIDI-capable music classroom.

Ajero's well-documented study focuses on two research groups of college-level piano students, attempting to determine the effects of using keyboard technologies on performance accuracy.[91] Each group used the same keyboard throughout the experiment. But one cluster used Computer Assisted Instruction (CUI) technology with MIDI and instructional videos of standard MIDI files; the control group did not. The study also provided a questionnaire to the students on their varying perceptions the experience. The participants practiced the same two pieces of music for fifteen-minute sessions, over the course of four classes. The first group practiced using a MIDI accompaniment on a Yamaha Clavinova, along with a computer software-assisted guide mode. The control group practiced with only the MIDI accompaniment. Both groups then performed their pieces without the assistance of any MIDI accompaniment or computer-assisted guide. Their performances were saved to floppy disks as standard MIDI files, and judged for errors in pitch and rhythm by a panel of three independent adjudicators – instructors at the school of music of Stephen F. Austin State University in Nacogdoches, Texas. Ajero randomized the performances prior to their evaluation before the panel.

The results of Ajero's study are startling. While the students who practiced with MIDI accompaniment and the computer assisted guide mode showed significant improvements over the control group in pitch accuracy – they more frequently played the correct notes – there was no significant improvement between the two groups concerning rhythmic or total performance accuracy.[92] The study group did, however, *believe* that MIDI assistance was more effective than it proved to be: "Although listening to the MIDI file was not rated highly in the Likert-type survey, some participants expressed their belief in its effectiveness as an aural model … Some students remarked how the technology was both helpful and motivational in their performance."[93] In effect, students had placed more *faith* in the abilities and accuracy of digital machines than they had in their skin-and-bones teachers. Ultimately, the study's findings became more about the educational effectiveness of technologies versus human agents. Ajero concludes: "One cannot expect to rely upon MIDI accompaniments and CAI technology to improve performance alone, but it still may serve as a valuable tool in the learning process … When used appropriately, implementation of technology that meets the pedagogical needs of teachers may provide valuable support for learners as well."[94]

All too often, it is taken for granted that music technologies expanded accessibility to music making, and made untold access to music-making possible. These assumptions are based upon the perception of more or less homogeneous student populations: upper-middle class, white, male; in many cases, manufacturers and the private sector supported the literature proposing that MIDI, computers, and all manner digital technology would revolutionize music education.[95] Electronic instruments were marketed *en masse* to educational institutions as part of music programs aimed at simplifying and speeding up the practice of learning music. They were seen as compact all-in-one enabling devices that could be had at a nice price, saving time, space, and money, allowing one child to create entire symphonies, and eliminating the necessity of repetitively mastering multiple instruments, or indeed much musical skill at all.

Queen's University music professor Kip Pegley's research on gender and music technology in education sheds light on how, in its infancy, MIDI's blitzkrieg implementation in elementary pedagogical settings further divided the sexes – but not necessarily for the anticipated reasons.[96] Pegley contends: "Implementing technology in music classrooms to the exclusion of all other musical interactions – including bands and choirs – is problematic for a plethora of reasons, and not all students are pleased with this trajectory."[97] Her study, based at the York University Centre for the Study of Computers in Education, looked at two schools in the Toronto area between 1991 and '93. One school was sponsored by the education department of a "major computer company," and was thereby fully kitted out with MIDI keyboards and other kinds of digital technologies for every student.[98] The second school had approximately one computer for every three students. Pegley's conclusions are interesting: especially the girls in both groups were more hesitant to embrace the technology not in spite of but *because* of its seeming facility. Pegley writes: "They were described as 'circumspect,' '[holding] back,' and 'purposeful.'"[99] It was not so much that girls were afraid of technology; they were more troubled by what they were missing out on: the deliberative process of learning an instrument.

In these enlightening case studies, girls were significantly more reticent to embrace MIDI-capable technologies than boys. Moreover, girls generally seemed to want to learn instruments together, whereas boys were content going it alone, and individually mastering the technology. But Pegley contests the conclusions that generally tend to be drawn for girls' comparative reserve: that technology is a masculine terrain, and that girls who take a keen interest in it are more marginalized by their peers. Rather, Pegley stresses the importance of meaningful interaction and reiteration, looking beyond the simple rehearsing of these problematic explanations, and rethinking "how we define repetition and how we can differentiate useful from meaningless repetition."[100]

Pegley argues that, for girls, it is less about what is gained than what is lost: the seemingly repetitive and time-consuming practice that music technologies promised to make unnecessary and obsolete actually cultivate more profound relationships. She calls them "pen and pencil" instruments, those with deeper cultural histories, encouraging more profound connections to one another. As it turns out, practices and processes that were once assumed to be prohibitive and redundant are actually quite crucial to making music – even electronic music. It is the technologies that were designed to overcome these redundancies that have hierarchical levels of prohibition programmed into their language, as it were. Electronic music technologies in these instances replaced the social and negotiated experience of playing and mastering traditional instruments, which made for less deeply rooted and meaningful cultural experiences around music, Pegley maintains.

Furthermore, they advanced a claviocentric and solitary approach to musical technology, instruction, culture, and history well into the digital age.

As we can appreciate from Pegley and Ajero's work, implementing MIDI into classroom and music education settings was not as easy as manufactures made it sound. Responding to mounting confusion and criticism throughout the 1980s, MIDI instrument makers and parallel industry associations sought to repair the image of MIDI as a user-unfriendly interface. Getting MIDI to function across instruments throughout the 1980s was not as simple as, say, installing an interchangeable roll in a piano player, or chording on a Hammond Piper. And, as we will see in Chapter 3, MIDI was implemented into a host of digital instruments and devices at such a rate that even instrument manufactures had a difficult time keeping up with advances in their own sectors, much less answer granular and arcane questions from individual users.

In 1992, The IMA, MMA, and NAMM commissioned music journalist and author of *The MIDI Home Studio* Howard Massey to pen an explanatory guide for music educators, entitled *Taking The Mystery Out Of MIDI*.[101] These pamphlets would be shipped cross-country to music retailers, and distributed to potential buyers of MIDI technologies, who may otherwise be hesitant to put money down on something they might not immediately know how to use. In its opening sentence, the guide sets up MIDI's claviocentric ideology, and the dream of being able to emulate and control any sound, any kind of instrument, with the keyboard: "Imagine being able to place the power of an entire orchestra at your fingertips."[102]

Massey describes MIDI as a fast, simple, efficient, and "magical" language – MIDI messages are received and interpreted as easily as a common language is heard and understood by a human listener. But to most people, MIDI seemed more like work than leisure. The hyperbolic tenor he deploys throughout is reminiscent of the adverting rhetoric around Pianolas, home organs, and other "easy-to-play" electronic instruments. Massey encourages: "Like so many other things in life, MIDI isn't nearly as involved as it first appears. Once you get past the jargon, you'll find that it is easy to understand and even easier to use. What's more, you really don't need to know all the intricacies of MIDI in order to use it effectively…"[103] This statement, however, was far from the truth.

Larry Mueth's 1993 article on MIDI in *Music Educators Journal* reads much like Massey's NAMM publication, as a kind of utopian pro-technology document designed to get reticent and potential users onboard. Mueth writes: "…the music educator can use MIDI to enhance student learning in the areas of composition, orchestration, and theory. We, as music educators, have only begun to utilize the potential of MIDI."[104] Again, this guide touts MIDI's simplicity, and the ability to produce and control several sounds with one keyboard, referring to the demands of a nebulous group of musicians as the agents behind the protocol: "Usually, multiple synthesizers were used for performance: one for string sounds, one for the fat bass patch, and another for the brassy lead. The synthesizer players wanted different timbres to sound simultaneously from a single synthesizer."[105] More than just producing entire orchestras with one's fingertips, MIDI was increasingly making the practice of making music more often than not a solitary exercise, and encouraging different kinds of abilities to count as, or all-out replace, traditional musical skills.

More Human Than Human

At some point, a division became apparent in the world of MIDI between those who wanted to make automatized performance sound more human, and those who craved to create music that was otherwise unplayable by mere mortal hands alone. In the 1970s, swappable patches and preset sounds made it possible to dial in any conceivable instrument palette into a keyboard instrument – percussion, strings, woodwinds, brass &c. With the proliferation of digital samplers, all manner of sound could be remapped onto a clavier keyboard. Sequencers rendered physically performing complex musical pieces unnecessary: compositions could be programmed into an instrument or computer software, saved, and played back precisely the same way, over and over again.

New technologies, and the new musical practices they facilitated, were on display in prominent popular cultural venues throughout the 1980s: take, for instance, Matthew Broderick's character faking out his friends on the phone, and then performing a Strauss waltz with cough, sneeze, and retch samples triggered by an E-mu Emulator in the 1986 John Hughes film *Ferris Bueller's Day Off*; many contemporary hip-hop musicians recall being inspired to take up digital sampling keyboards after seeing Stevie Wonder "play" the Huxtable family's voices through his Synclavier in an episode of the *Cosby Show* from the same year, entitled "A Touch of Wonder."[106] With artists like Duran Duran and Jan Hammer appearing on newly emerging music-television programs like Top of the Pops in the UK, and dedicated stations like MuchMusic in Canada and MTV in the US, MIDIfied music was becoming more and more visible. And individual artists like Harold Faltermeyer were producing the scores for films – most notably, for the *Beverly Hills Cop* and *Fletch* franchises – with digital studios using MIDI. Through MIDI, feats of super-humanity and virtuosic intricacy could be achieved.

Because entire orchestras could be created with a single keyboard, the majority of popular forms of music produced electronically during its brief history are most likely to be the work of a solo artist. MIDI is arguably in large part responsible for today's over-abundance of lone (and usually male) electronic music producers, regardless of talent or inspiration. I claim that the technical ability to solitarily create an entire compositional sound in an affordable home studio in the 1980s contributed to a recent culture of auteurist electronica artists. This scene has individual producers practicing personal and exclusive signatures – importantly, signatures that can also be applied through collaborations to strengthen the symbolic weight of others' hegemonic documents – rather than writing an elaborate tapestry of music, negotiated and solved through necessary cooperation and inclusion. In many ways, the solo artist has become the whole equation of digital music, and its solution.

Moving into the mid-1990s, bands like Nirvana and Oasis became scarcer on the popular musical landscape, being steadily replaced by DJs and solitary producers such as Moby, Fatboy Slim and DJ Shadow – artists who were eager to realize their personal ideas of music by toiling alone in a studio, cutting-and-pasting together pastiches of recorded music using MIDI-triggered samples and sequencing software for computers. At the time of writing, solo electronic artists in the recently invented genre of Electronic Dance Music are more ubiquitous than ever, from Skrillex to Deadmau5, Burial to Diplo, Dan Lopatin to Deadbeat – the list goes on. Even female electronic artists are more prone to be solo acts, like Laurel Halo, Ikonika, and Holly Herndon. It is ironic that standards such as player piano rolls and the MIDI specification, which relied so heavily on industry cooperation and compromise, seem to perpetuate more isolating practices when it comes to their users, whether professional or amateur.

In the late 1940s, an unknown American composer named Conlon Nancarrow acquired a piano roll-punching machine, and began experimenting with composing his own extremely intricate player piano music. By programming original embroidery-like patterns based on complex mathematical equations onto the rolls, Nancarrow realized that he could quickly create music that was far beyond the technical capabilities of any human pianist. The effect of listening to his "Study for Player Piano No. 37," for example, is one of uncanny disbelief, yet it is not the most listener-friendly in terms of classical musical convention. As such, his works were born into obscurity, only to be rediscovered in the late 1980s – around the same time that MIDI was making its mark on machine-made music – and retrospectively placed rightly within the experimental lineage of John Cage, Morton Subotnik, and Laurie Spiegel.[107] Suddenly, his compositions were being "performed" at Lincoln Center, the Holland Festival, and the Mechanical Music Festival in

Cologne; for the sake of posterity, as well as for future "live" performances, his rolls were transcribed into MIDI-compatible computer files in 1989.[108]

In the early 21st century, similar kinds of thinking inspired the "Black MIDI" movement, which prizes composers for the number of notes that they can pack into a single piece. The term "Black MIDI" refers to its unconventional visual representation: in standard musical notation, compositions appear as almost complete black blocks rather than discrete individual notes. It is curious to point out that the Black MIDI scene plays for note counts above other musical or aesthetic considerations, in a sort of competitive and dedicated game-like social community.

Like Nancarrow's piano-roll compositions, Black MIDI pieces are programmed into piano education-type software like *Synthesia* to play back impossible music composed of literally millions of notes – "Bad Apple" by a user called TheSuperMarioBros2 contains over 4.6 million separate notational events.[109] Robert Barry of *The Quietus* enthusiastically sells Black MIDI as "[giving] back to computer music its long lost element of utopia."[110] Yet, I would argue that making Black MIDI music is far from ideal; on the contrary, it is in fact the dystopian byproduct of a claviocentric mentality in both popular and experimental musical terrains, isolating musicians in front of keyboards and monitors, competing alone-together as if in some virtual arcade game.

Conclusion

MIDI may be a standard for the transfer of digital information from one musical instrument to another; but the MIDI protocol was imagined based upon the deep-historical standardization of the keyboard, and the 12-tone musical scale. And once standards are set in motion, like a runaway train, it is very difficult to change their direction. Beginning in the 14th century, the clavier keyboard began to dominate Western musical instruments, new technological innovations, as well as the kinds of music composed with and for them. It was hard to argue with an instrument that employed a harmonic system rooted in the work of Pythagoras and his followers. Whether the intention of composers was for a performance by a solo pianist, or a choir, or an entire orchestra, more and more music was composed within a culture of claviocentrism. Although harpsichords and organs were immensely popular music machines, the regulation and variation of sound possible with a piano initiated, as Anita Sullivan argues, "a process by which the tail (the piano keyboard) began to wag the dog (the tuning system that underlies all Western music)."[111]

Subsequently, trade in pianos and other keyboard instruments flourished throughout Europe, and later, in the United States. Borrowing from the model of hire payment popularized by the Singer sewing machine, piano manufacturers began introducing deposits and payment plans to stimulate the purchase of what might otherwise be an unaffordable and impractical commodity. Pianos entered the modern economy just as swiftly as they entered bourgeois homes, literally becoming part of the furniture by the mid-19th century. And music education gained increasing importance, with piano lessons dominating both public and private classrooms. Gradually, mechanical instruments such as the metronome and other forms of musical automata began augmenting traditional piano performance, and assisting in pedagogical roles. But formal music education was costly in both time and money for large sections of the population.

From the mid 1900s on, clockwork organs and player pianos gained increasing prominence, and "easy-to-play" instruments quickly took over the music trade. Prior to gramophones and radio – recorded and broadcast music – manufacturers scrambled to implement systems and standards which enabled instruments to play themselves. Popular piano music was becoming evermore mechanical. As a result of musical technologies, the values surrounding musical production practices were changing too; no longer was musical ability tied to the prolonged duration of cultivating technique and talent. The exercise of making music was viewed increasingly as a leisurely rather than laborious activity – a pastime that might become a profession.

With the onslaught of new keyboard products into the marketplace at the turn of the 20th century, manufacturers' and retailers' organizations formed, ostensibly to self-regulate, but also, importantly, to protect their own interests and expand their industries. Cooperation seemed at odds with competition, but ultimately proved profitable for piano manufacturers – just as it would for manufacturers of MIDI-capable instruments less than a century later. As radio and recorded music media silenced the player piano into the 1930s, electric organs and other consumer durable "process innovations" took over the instrument industry. These apparatuses found their way into public consciousness via popular hit records, their distinctive timbral sound colors differentiating them from the kinds of tones possible with a traditional piano. Innovations by Laurens Hammond and

Ikutaro Kakehashi, Bob Moog, and other American synthesizer designers reignited a stagnating keyboard trade, perpetuating the claviocentric model well into the digital era. But the keyboard also cultivated more solitary practices of making music, and automation has led notions of musical proficiency steadily away from a traditional and durational acquisition of expertise, and toward immediacy and technological literacy. Selling MIDI as an "easy-to-use" technology proved more difficult than expected, even to its core market of synth players. Nonetheless, by the time MIDI was conceived of in the early 1980s, the piano was so well entrenched into the fabric of Western music making, it seemed nearly inevitable that it be designed first and foremost for the keyboard – eternally the lady who swings the band.

Chapter 2: Avant MIDI, Après-MIDI

"What if Shakespeare had a word processor?"[112]

NAMM did an excellent job of collecting stories from manufacturers and musicians, and in doing so, ensuring its own legacy in major industry shifts like MIDI. In the spring of 2000, NAMM's Resource Center – a closed library of records and archives from manufacturers, retailers, and musicians – inaugurated its Oral History Program, to compile interview footage of key musical industry professionals, and the artists who played their instruments. The Program was imagined ostensibly to document the often interesting and important stories behind each participant, but their over-arching goal was really to produce a kind of curated historical repository of the musical products industry, situating NAMM itself at the center – the organizing force behind this technological and cultural constellation.

Each video is logged, watermarked, and tagged with searchable keywords – keywords like Guitars, Synthesizers, Kurzweil, Jazz, or MIDI, for instance. The videos are further navigable by a long list of filters that subdivide participants according to their vocation and connection with the industry: categories like music retail, manufacturing, publishing, industry associations, musicians, bands and orchestras, and the like. Truncated clips of these interviews are posted on NAMM's website, but the lion's share of this enormous volume (many interviews run well over an hour) is housed on hard drives at their Carlsbad, California headquarters. And at the time of writing, dozens more are conducted per month. The Oral History Program is so important to NAMM, in fact, that they surpassed tenfold their own ten-year goal of 100 interviews, completing over 1300 by April 2010.[113] The bulk of material for this chapter is culled from these MIDI-tagged interviews. In a few cases, I have also supplemented NAMMs research with my own. This section will chronicle the roots of MIDI, as well as some of its descendants and benefactors.

Of course, personal accounts and unfurling yarns must be treated with a degree of caution. Ultimately, MIDI allowed for the consolidation of an entire segment of the musical instrument marketplace, engendered massive shifts in the corporate climate of digital musical products, and shaped the aesthetic qualities of subsequent electronic music. Everyone involved naturally wants credit where credit is due, and some, even where it is not. In addition to NAMM's explicit and implicit motives, each participant has his or her own slant on history. Personalities conflict. It is just as illuminating to see where participants refute one another, as it is when they seem to corroborate each other's testimony. From these intersections, another more Roshomonic story begins to emerge, one in which MIDI was not an entirely new concept, in some cases an inferior technology, and certainly not universally embraced. Some interviewees were friendly; some were in direct competition with others; some were involved in legal disputes. These incomplete and often conflicting narratives give shape and contour to MIDI's short and convoluted history. Additionally, MIDI derived its influences from some less likely places than dominant genre histories of electronic music often care to admit. Everyone loves to trot out Devo or Kraftwerk as torchbearers of Techno. Fewer mention the Mahavishnu Orchestra or Weather Report.

Histories of musical genres comingle with histories of instrument technologies in interesting and profound ways. It is common, for example, to read in the NAMM archives that 'X' technology 'revolutionized' genre 'Y', or how band 'Z's' use of 'A' changed the sound of music forever after. Histories around MIDI are no exception. In 2013, after Dave Smith and Ikutaro Kakehashi took home Technical Grammy awards for their contributions to the MIDI specification, a smattering of enthusiastic anniversary articles and interviews appeared, via such authoritative channels as the BBC, touting the 30-year-old standard as "a revolution in music and recording production," the facilitating force behind electronic music's meteoric rise – a commonly held technologically determinist fallacy.[114] The truth is neither as simple, nor hyperbolic.

Unlike the Japanese manufacturers, who envisaged growth through cooperation, American companies were in the business of distinguishing themselves within the synthesizer marketplace: ARP never put control wheels on their synthesizers, for instance, because Moog already had.[115] Dave Smith is most often credited with rallying the Americans behind MIDI, and his company, Sequential Circuits, indeed played a major role in writing the specification. But they were not the first company to put microprocessors in their synthesizers, nor to develop their own system of remote control. E-mu was ahead of them in the digital domain, and Tom Oberheim's interface made his company just as likely of a potential participant in MIDI's development.

Jazz keyboardist Herbie Hancock and organist Don Lewis had created custom-built multi-manufacturer keyboard controllers in the late 1970s. And by the early 1980s, Oberheim and E-mu were both working on their own proprietary systems of machine control. Sequencers for analogue and digital synthesizers were becoming more commonplace. And microchips and other digital technologies were helping to stimulate an impetus toward producing all-in-one workstations. When it came time to ratify the MIDI specification, E-mu and Oberheim were largely cut out of the deal, in part because they had their own control systems in the works. Tellingly, Sequential Circuits was the only company in the United States actively involved in the MIDI specification at the development stage, but there were other Americans working on interfacing electronic instruments.

Prog and Jazz: The Roots of MIDI

Very few histories of electronic music posit the organ as a pivotal instrument.[116] But a reasonable claim can be made that the legend surrounding, say, Bob Dylan's "electric" Newport performance, which enraged a Connecticut Folk festival audience and incited the otherwise peace-loving Pete Seeger to replace his hammer with an axe, was as much about the screaming distortion coming from the Hammond as it was about Dylan's amplified guitar. In his book *Instruments of Desire*, Steve Waksman recounts this event as a gesture "toward a new hybrid of folk and rock sensibilities" that shows how significant the electric guitar was to popular music in 1965.[117] The Hammond might not have been as sexy or hip looking, or even as immediately visible as Dylan's Stratocaster, but it still produced a lot of sound, upset the Folk enthusiasts' ideas of instrumental authenticity, and stoked their scorn for the mixture of music and electricity. The organ equally infuriated early audiences of Strawbs, a British Folk band that, in the late 1960s, added young keyboardist Rick Wakeman to their lineup. Wakeman went on to play session parts on hit recordings by David Bowie, Elton John, and T-Rex, and eventually became the full-time keyboardist for Prog Rock pioneers Yes. But prior to that, Wakeman freaked out Folkies by shaking his Hammond A102 onstage with Strawbs, rattling the internal echo plate and making an awful electric racket.[118]

Keith Emerson, likewise, was pulling similar stunts – tipping, kicking, and sticking his organ with knives – in his band, The Nice, before coming to prominence in the 1970s with Emerson, Lake, and Palmer.[119] Both Emerson and Wakeman were renowned for performing from within a circle of synthesizers, and Dance, Electro, and Industrial musicians emulated their setups for decades afterward. As Yes, ELP, and other Prog Rock acts like Pink Floyd, Genesis, and Rush gained increasing popularity, and artists like Wakeman and Emerson collected more and more instruments, stacks of keyboards became mainstays of the stage. But with all this new technology, they each ran into a very human problem: the limitations of ten fingers.

Herbie Hancock and Bryan Bell

This hitch led Bryan Bell, one-time sound engineer for Carlos Santana and the Mahavishnu Orchestra, to create something special for his new boss, Herbie Hancock. Hancock hired Bell full-time by the mid-1970s. Bell quickly realized that he would be spending the rest of his career tuning keyboard instruments if he could not find some way of interfacing them all together.[120] After becoming obsessed with synthesizers, Hancock's setup ballooned to include two Minimoogs, two ARP 2600s, an Oberheim 8 voice synthesizer, a string synthesizer, a Clavinet keyboard, a Fender

Rhodes electric piano, and an acoustic piano. The Rhodes and Clavinet were electro-mechanical instruments that required constant tuning and repair, as did the acoustic model. The ARPs and Minimoogs were monophonic analogue synthesizers, meaning that only one note could be played at a time. Two simultaneous notes required two ARPs and two Minimoogs. If Hancock liked an instrument, he frequently took two.[121] And he was known as somewhat of a soft touch when it came to trying, and sometimes even buying, new instruments. When Tony Furse, an unknown Australian computer engineer, arrived in Hancock's driveway with a Winnebago full of Fairlights – the $25,000 digital sampling synthesizer and computer music interface he, Peter Vogel, and Kim Ryrie brought out in 1979 – he called Geordie Hormel, proprietor of Village Recording Studios in Los Angeles, and persuaded him to become the company's US distributor, just so Hancock could purchase the first one.[122]

Putting all these instruments together was one thing in the studio, but produced an altogether different beast for going on the road. Touring was a significant consideration, and a necessity for the professional musician, which posed its own set of problems. Instruments were heavy. And keeping things in tune was always problematic. To Bell's mind, new instrument manufacturers did not understand the lifestyle of the touring artist. Most digital displays could not be read in the sunlight, for example. Hancock had to represent 10 album's worth of material live, which required carting around a small arsenal of acoustic and electronic gear. As well, Hancock noticed that, because of a perceptual phenomenon called "foldover" – where harmonics in the lower frequency range produce audible dissonance and noise when transposed higher up the scale – certain instruments were very good at producing rich timbres, but at different ends of the keyboard. The Prophet 5, for instance, had a thick bass sound, while the Oberheim was better at generating smooth high tones. Hancock and Bell wondered if it would be possible to have a handy road-ready keyboard, split down the middle, which could control them both.

Because of Hancock's fame, Bell enjoyed the luxury of having Bob Moog and Tom Oberheim at a telephone call's distance. But they were remiss in their suggestions. Bell recalls that Moog responded by telling him to just "buy more Moogs," and Oberheim threatened to void his warranty should he attempt to interface synthesizers from other manufacturers.[123] Despite the forward thinking nature of the electronics industry (Moog was a big fan of Pink Floyd, ELP, and Hancock as well) both Moog and Oberheim still could not quite conceive of their instruments from a musician's perspective, and particularly that of the performing musician. Furthermore, American companies were not prone to cooperating with each other, regardless if it might satisfy Herbie Hancock's whims. Investing in making one's product compatible with the competition just was not part of the US business mentality.

Despite Oberheim's warnings, Bell began working on a system of universal automation for Hancock's instruments. He found a master keyboard in the E-mu 4060, which would provide digital control, and had 5-note polyphony, meaning five notes could be played simultaneously. Because there was yet no storage for instrument settings, Bell used a Radio Shack cassette drive for memory. E-mu's engineers faxed him the source code so he could write his own software. Hancock had met with Xerox computer scientist Dr. Alan Kay in 1976 to discuss the possibility of networking instruments and computers, had gone to Japan to be among the first to record in Sony's PCM-1 format, and they were well aware of digital advancements and the general direction in music technology at the time. So, Bell conceived of a computer-controlled system that would automate not only synthesizers, but also treat the entire studio as a computerized instrument. Between 1978 and 1980, they designed and built a digital system at Automatt studios in San Francisco, that could control all of Hancock's electronic instruments, plus the mixing console, patching, sheet music notation, chase SMPTE video time code, and reset the studio's parameters 12,000 times per second. Hancock recorded three albums there in as many years, and began helping to develop the alphaSyntauri, a software synthesis company that counted Apple Computer's co-founder Steve Wozniak as a fellow board member, before folding in the Yamaha DX7's shadow during the mid-'80s.[124]

Right when MIDI was being sketched out, Hancock and Bell were in the position to do some actual innovating: they had significant development money available from Hancock's record sales (he had twice achieved the highest-selling instrumental album, and would a third time with *Future Shock*), and access to the finest minds in the instrument and electronics industry. Arguably, Bell and Hancock were invested in the kind of research and development more fit for a major synthesizer corporation than a solo Jazz artist. At the time, five megabytes of digital memory carried a cost $30,000. Bell built his own 16-bit computer system with a processor chip procured shadily from a "defence contractor."[125] Just because Hancock played Jazz did not mean his system could be close enough for Jazz.

They figured that, in order for the network to accurately interpret and reproduce intricate performances, a 192nd note clock would be necessary to interpret Hancock's complex timing and other live eccentricities. This was far more resolution that Dave Smith and company had in mind for MIDI in the early 80s. Bell attended initial conversations about MIDI development held at NAMM shows and elsewhere, and was underwhelmed by its first demonstrations. According to him, Smith and his contemporaries already had radically different ideas about what a control system should do from the beginning: Smith wanted to layer sounds; Roger Linn, for example, wanted to be able to sync a universal clock from his drum machine. Everyone wanted to be master. When Bell saw that MIDI was becoming more about shifting consumer products than developing sophisticated professional instruments, and knowing that he had already built a superior system in many ways, he shied away from the conversation.

Although it was adopted at whirlwind speed, Bell believes it took a full five years for MIDI to become stable enough as a standard within the industry to truly address touring needs in instrument development. Every electronic musician has a stage-related MIDI horror story to tell. Hancock had conceived of rack-mounted modules and virtual synthesizer configurations in the mid-1970s, and Bell filled in the technological delay between studio and road gear. They began by trying to capture the singularity of live performance, but after MIDI, the artistry of engineering turned toward trying to make the live show sound exactly like the record. The most significant casualty of MIDI, according to Bell, was musical skill. Artists could now make better records than they could play live. By programming notes into a MIDI sequencer, instruments could be played with machine-like precision, again and again and again.[126]

Hancock was more forgiving of the standard, remaining friendly with a variety of manufacturers and developers of hardware and software. He became a beta-tester for Lone Wolf, a company that created a long-range fibre optic system called MidiTap, and also made a point of getting pleasant with newer players like Digidesign and Waves. He had no reason not to. Still, "Rockit" was made without MIDI.

Oberheim Electronics

In 1970, Tom Oberheim founded Oberheim electronics in Oakland, California, to manufacture electronic effects, like ring modulators and phase shifters. Oberheim was a Kansas State-educated electrical engineer who had cut his teeth in the mid-1950s printing circuit boards at the Van Nuys airport, for the missile division of Lockheed.[127] His military associations continued into the decade's end with a draftsman job for National Cash Register in 1959, which was contracted to create a time-code generator for rocket systems. The work left much to be desired, and Oberheim followed his passion for music, making small custom electronics instruments for musicians. His devices were popular in a cult sphere: in 1969, Oberheim received a call from Leonard Rosenman, the infamous film composer, for assistance on the score to *Beneath the Planet of the Apes*.[128]

Oberheim was aware of the instruments being manufactured by Moog and ARP, and even sold ARPs briefly.[129] But he, too, had his eyes on the digital domain. Oberheim produced one of the first digital sequencers for analogue synthesizers, the DS-2, a device capable of recording and playing back rudimentary performance information. But monophony was a problem: if the sequencer was playing, you could not play along with it. So, he built the Synthesizer Expander Module that would make it possible to play more than one note at a time with the running sequencer. In 1975, Oberheim released a 4-voice polyphonic synthesizer – the first affordable instrument of its kind – using a patent from E-mu Systems (more on this later). And in 1970, the company introduced the OB-X, a polyphonic synthesizer designed to compete directly with Sequential Circuits' Prophet 5 (more on this instrument later). One year afterwards, Oberheim brought out an update, the OB-Xa, which most notably featured the CEM chip (more on this later, too), and the ability to split the keyboard, allowing players to select two simultaneous voices – the innovation proposed years earlier by Herbie Hancock and Bryan Bell.

Jim Cooper, an Oberheim engineer at the time, thought it would be interesting to try hooking up the OB-Xa to a computer sequencer, and designed what Oberheim described as a "quick and expensive" interface.[130] In 1981, the company introduced the DMX drum machine, designed to work with the OB-Xa. The network was called "The Oberheim System," but was limited to use only with other Oberheim instruments. It was around this time that discussions started forming around MIDI. Given his expertise with digital interfacing, Oberheim was one of the few Americans approached by Roland to help put together a universal protocol. Yet, feeling that they had already created a sufficient interface for their own products, Tom Oberheim was lukewarm to the discussions, and eventually backed out, leaving Dave Smith as the sole American in the budding consortium. As a result of their slow adoption of the MIDI standard, Oberheim suffered into the 1980s, and his company never fully recovered their cutting edge position in digital musical instrument development.[131] Still, in 2008, Oberheim was invited by Red Bull Music Academy, the energy drink-sponsored series of music workshops and performances, to deliver a lecture in Barcelona on his pioneering role in designing electronic music machines.[132] His location in the history of instrument design was reinstated retroactively. By the end of his visit, he had taken several orders from attendees, and has since made a tidy business of remaking updated versions of his old analogue gear.

E-mu Systems

Dave Rossum and Scott Wedge founded E-mu "Starships and Synthesizers" in the early 1970s, to produce modular analogue keyboards that would compete with concurrent Moogs and ARPs.[133] Rossum was a psychedelic wanderer, but Wedge had a mission to "make synthesizers mellow."[134] Both attended college in the Bay Area, and their unlikely company was first headquartered in Rossum's Santa Clara apartment. While modular synths were their first concern, digital control was soon simmering on the back burner. In 1975, they were among the first synthesizer companies in the US to turn their attention to microprocessors. Rossum and Wedge built a computer using a Zilog Z-80 processor, which served as a development and programing system, and also conveniently ran their company's accounting and inventory.[135] E-mu programmed its own exclusive interrupt-based real-time operating system, using the Z-80 chip. The interrupt system meant that the microprocessor's routines would periodically be broken to perform smaller tasks, making the computer much quicker to respond to commands than other popular chips of the day. This is significant for synthesizers, since notes would have to sound immediately when played, rather than to endure a lag, which would make performing on the instrument feel and sound unnatural. E-mu's first microprocessor-based product, the 4060 keyboard, began shipping in 1977 – the same synthesizer Hancock and Bell used for their pre-MIDI split keyboard prototype.

Rossum and Dave Smith were familiar from their college days, and Smith asked for E-mu's assistance when building his first sequencer. According to Rossum, Wedge persuaded Smith to use an E-mu-designed voltage controlled oscillator or VCO (an electronic sound oscillator that uses electric voltage input to control its frequency) as its timing base, which initiated an economic relationship between E-mu and Smith's fledgling company, Sequential Circuits.[136] At the same time, Rossum and Wedge had been busy designing a polyphonic digitally controlled analogue keyboard, and working with Solid State Micro-technology, or SSM, on an integrated circuit (IC) voltage controlled amplifier (VCA) chip. Rather than using transistors, ICs put all of its components upon a single chip, miniaturizing and simplifying the manufacture of electronic parts. Oberheim was impressed enough to license the polyphonic patent for his 4 and 8 voice synthesizers. Smith, too, was interested in expanding his line of products to include a digitally controlled polyphonic analogue synth and, already being a customer and friend, licensed E-mu's patent, analogue design, and Z-80 assembly code for the Prophet 5. The Sequential keyboard used the SSM chips that Rossum had participated in developing, as well as E-mu's now well-worn polyphonic synth design. And because Smith's company was just getting its footing, E-mu agreed to take no initial payment, with a promise of $75 on every Prophet sold.[137]

By 1980, several things happened. The Prophet 5 had become a huge commercial success, and E-mu was receiving checks from Sequential for $15,000 a month. But Sequential was still facing problems. Smith's initial design for the keyboard had minor flaws, which scaled poorly in mass production. SSM, too, had not considered how their chips would function in volume manufacture, and neither did Exar, their supplier. Meanwhile, Doug Curtis, a Northwestern-schooled engineer, was starting his own company, Curtis Electromusic, producing custom CEM ICs designed to compete directly with SSM. Eventually, Curtis wrangled Sequential's business away from SSM, and the third iteration of the Prophet 5 contained the more stable, more scalable, CEM chips. E-mu, furthermore, had suffered defeat in a rare patent interference hearing that stripped away many of their claims to the Prophet/Oberheim polyphonic synthesizer design. In May 1980, Sequential Circuits stopped paying E-mu altogether, and E-mu initiated a court battle that would take several years to settle. Rossum believed that Sequential Circuits' design rested on more than just the SSM chip, but Smith felt differently, and the patent interference ruling did not help E-mu's case. Following the verdict, Rossum and Smith broke off communications completely.[138]

The massive loss in revenue from Sequential's rebuff and the ensuing legal proceedings forced E-mu back to the drawing board. Their experience with digital systems led them to design the Emulator, an inexpensive digital sampling keyboard first released in January 1981, and also based on their Z-80 design. Rossum explains that the first Emulators included on their motherboards an RS-232 connector for a monitor display. They incorporated it for the purposes of debugging the operating system, but it also made it easy to visually interact with basic routines – like note-on and note-off events, for instance. In mid-1981, E-mu was contacted by Jim Miller, a Los Gatos, California-based computer engineer who was writing sequencing software for an IBM PC. He wanted to use his software to control the Emulator, so E-mu agreed to give him access to their specs. Two years prior to the official launch of MIDI, E-mu and Miller had designed their first digital interface for controlling synthesizers.[139]

Rossum claims that he first heard about MIDI only two weeks before the January 1983 NAMM show. They were reluctantly asked for comments by the MIDI consortium, and Rossum provided several. He wondered why they did not simply adapt one of the many serial protocols that had already been well established. He also took issue with MIDI's 7-bit transfer, its asynchrony, and most of all that it was a serial interface to begin with. E-mu's RS-232 interface was parallel, which allowed for both connected devices to send and receive commands. MIDI's serial interface meant that only one machine could be master, and all others slaves. Effectively, there could be no negotiation between interfaced instruments. Because Rossum and Smith were still not on speaking terms, E-mu sent one of their employees, Ed Rudnick – who had previously worked at Sequential Circuits – to represent them at the January ratification meeting. But Rudnick reported that E-mu's feedback was most unwelcome: the deal was already done. They could either adopt it the way it was, or be left out altogether.

As a gesture of appeasement, Rossum was asked to join the MIDI technical board.[140] He served for one year, but was frustrated with the political nature of negotiations. Rossum also found that the Japanese manufacturers exerted considerable clout, in some cases requiring the specification *not* to specify details, such as in the case of pitch bend control information. He could not fathom why instrument makers would agree to a protocol that, in his view, deliberately defied a degree of standardization. Ultimately, Rossum bowed out of MIDI regulatory discussions, and resumed designing instruments with E-mu, albeit now including MIDI.

In 1982, the company released the Emulator II, an updated version of their original sampler, which incorporated a higher sampling rate, a dual floppy disk drive, expandable RAM, and ports for an external hard drive. The device was such a success that Paramount Pictures contacted Marco Alpert, E-mu's then head of marketing, requesting one for an upcoming film production. Alpert agreed, on the condition that E-mu receive an acknowledgement in the credits. Consequently, the Emulator II played a prominent role in John Hughes' *Ferris Bueller's Day Off*; Hughes was so taken with the machine that he purchased it (at wholesale cost, of course) for himself after the shoot wrapped. The film's soundtrack was heavy on electronic music, and the Emulator became couched within a cinematic constellation of new technologies, consumer durables, and ways of life. It is significant to point out, too, that much like the player pianos and organs of yesteryear, the sampler was portrayed in the film as an easy-to-use device associated with youthful freedom, upper middle-class affluence, technological trickery, and the film's tagline, "Leisure Rules."[141]

Figure 9: Leisure Rules: Matthew Broderick as Ferris Bueller.

The Ballad of Don Lewis

Don Lewis is a soft-spoken organ player originally from Denver, Colorado who relocated to San Francisco in the late 1970s.[142] Lewis' act was a complicated one-man band setup including a multitude of keyboards; but as with his Prog Rock contemporaries, he suffered from the human limitation of only having two hands to play walls of synthesizers. In 1974, before MIDI was even a glint in the eyes of Dave Smith and Ikutaro Kakehashi, Lewis conceived of the ability to control synthesizers from multiple manufacturers with one central keyboard. He imagined a main organ console that would control a horde of sound generating devices – an instrument that would later be named "LEO," an acronym for "Live Electronic Orchestra."

Figure 10: Don Lewis' "LEO" on display at the Museum of Making Music, Carlsbad CA, March 2014.

In 1977, construction began. Lewis hired friend and engineer Richard Bates to assist him with the design, amalgamating several different synths together with large-scale integrated circuitry. Eventually, LEO contained six synthesizer modules – ARPs, Moogs, Oberheims, a drum machine, Space Echo and chorus – all controllable from three keyboards and a batch of colorful buttons and sliders on its front panel. Inside was a power supply and drawbars pilfered from the Hammond Concorde organ, and rows of handmade circuit cards connected by snakes of wire. The entire contraption was housed in Plexiglas, allowing a view of the machine's beautiful twisted guts.

Lewis had a regular spot at the Hungry Tiger in San Francisco, but he often supplemented his income by playing union gigs. LEO was a hit among audiences, and Lewis could fit the contraption into rooms and spaces that regular orchestras could not. But some musicians were not as fond of LEO as Lewis and his fans. Unbeknownst to Lewis, resistance was mounting. In 1984, the local 6 chapter of the American Federation of Musicians picketed an Oakland concert, claiming that his instrument was robbing due-paying instrumentalists of their jobs. The case was sent to the National Labor Relations Board for review, which ruled against Lewis (according to him, it was over misfiled paperwork).[143] So, Lewis and LEO were effectively barred from working in San Francisco – forced onto the travel circuit to avoid the blacklist.

The board's decision was not entirely incorrect; there was a genuine fear that a device like LEO would put professional musicians out of work. But in contrast to unionized manufacturing, like auto workers for example, whose jobs were literally being replaced by robots, the line was fuzzier when it came to music makers: it was more a stretch of the imagination to claim that machines were replacing human musicians. The same could also be have been said for DJs, who had been steadily replacing bands in nightclubs for years prior. But the 'L' in LEO gave the union fuel. Unlike pre-recorded music, it was the performance element of Lewis' Electronic Orchestra that effectively hammered LEO's last nail. If Lewis could perform solo live what normally required 70 instrumentalists, the union could make a stronger claim that LEO posed an authentic menace.

Ultimately, Lewis tendered his resignation and never worked with LEO professionally again. But the concepts behind his work would be winning Grammy awards 30 years later. In 2013, for their MMA-sponsored 30th anniversary exhibit entitled "MIDI Makes Music," NAMM's Museum of Making Music had LEO reconstructed and positioned prominently next to early MIDI instruments from Roland, Sequential, Yamaha, and Korg. Even Mr. Kakehashi now credits Lewis as a forerunner and inspiration of MIDI. And LEO is the subject of a 2015 documentary film by Ned Augustenborg, entitled *The Ballad of Don Lewis*, featuring interviews with Kakehashi, Quincy Jones, Bryan Bell, and NAMM historian Dan Del Fiorentino.[144]

The blacklist against Lewis highlights how labor relations, and corporate competition and culture shaped the development of technologies leading up to the MIDI standard in North America and beyond.[145] There was a real fear that technological innovation could cause legal trouble, and so rather than broadcast news of new product developments, US-based companies tended to keep things under wraps. Especially in California, a state with a long history of union activity in advertising jingles, film scoring, and television production, MIDI-capable instruments spelled trouble. Urban legends abounded of musicians being called in for union sessions and secretly sampled.[146] In an attempt to appeal to all of its members, Bernie Fleischer, President of the Hollywood AFoM local said in 1985: "This union represents the synthesists, too, you know. As long as they're used properly, there's nothing we can do but welcome [synthesizers] into the musical community."[147] But the non-synthesists were not having it. The idea that sounds –

sounds that once had to be performed acoustically, or programmed by someone with a degree of expertise – could easily be replicated, stored, and transported interchangeably made synthesizers the enemy of the working musician, and peripherally made sounds themselves hot commodities. As a systems protocol, MIDI was integral in standardizing not just the interfacing of digital instruments, but also their voices.

Presets, Patches, and PCM

Don Lewis foresaw in the mid-1970s a piano instrument that would, among myriad other sounds, have "an organ button on it."[148] But individual synthesized sounds, sometimes referred to as patches, could not be saved or recalled on analogue synthesizers made by Moog and ARP. There were preset patches like those on the Polymoog – buttons that would call up the instrument's various voices – but settings could not be stored. Until Sequential Circuits' Prophet 5 shipped, synthesists had to remember which knob was at what value, and their signature sounds were recreated with slight differences each time. Designing voices with analogue modules was something of an art form. Making the spacey kind of timbres associated with analogue synthesizers was not the goal of the average or amateur player who might want to sit down at a synthesizer the way one would at the piano or organ. But getting a sound from them was not as simple. The hardware had to warm up; they needed constant tuning and recalibration, and programming them to emulate the nuances of other instruments, like the timbral characteristics of a trumpet, for instance, required sophisticated knowledge. It could be done, but setting up analogue synthesizers to produce complex waveforms and acoustic instrument-like harmonics was facilitated ultimately with digital technology.

Even when digital sampling devices entered the equation, it was not as easy as recording one note of a piano, or a single guitar string, and having a realistic-sounding piano or guitar patch. When digital samples are played back at different pitches – on different keys of the keyboard – their duration changes up or down accordingly, deforming attack, decay, sustain, and release in ways that sound progressively more abnormal the further away they get from the root key. And sampling every key of an acoustic piano requires minutes – not seconds – of sample time, simply an unaffordable option in the early 1980s. Arguably, it was not Bryan Bell, nor Don Lewis, who was making it possible to circumvent the professional musician; it was the engineers who made synthesizers sound like other instruments. Not that it was their fault.

Rival Dealer

In the early 1970s, John Bowen was a musician and Berkeley undergrad. He played keyboard and bass, but what he really wanted to do was fiddle with the Moog the University bought for its graduate music students – undergrads were barred.[149] Nearby Mills College put on a series of synthesizer concerts that Bowen attended, and he became progressively more interested in electronic musical instruments. He found an ARP 2600 at a local music shop, but was frustrated not being able to make a sound with it. And it was out of his price range. So he bought the manual.

A few stores rented out musical instruments, and musicians realized that they could make some extra money by hiring their gear out to students like Bowen. Paul Beaver and Bernie Krause, the pioneering San Francisco electronic music duo, frequently rented their Moog III when not otherwise in use.[150] Don Weir's Music City had a MiniMoog, which Bowen preferred, that they let out for $50 per weekend. Bowen continued to practice. In January 1973, he landed a job at Skip's Music. In March of that year, Bowen attended a NAMM show in San Francisco, where he sidled up to the Moog booth inquiring about how to get a job as a sales rep. He dropped off a demo tape of himself playing Emerson, Lake, and Palmer's "Tarkus," and waited. By June, he was presenting Moogs at the Summer NAMM show.

In the off-season, Bowen was charged with shadowing the current Moog representative, Doc Bochenek, who was not really a synthesizer expert. When Moog, the company, was sold to Norlin Corporation, Bowen became Bob Moog's right-hand man. They traveled together to a Tokyo tradeshow, where Norlin insisted that Moog wear a tuxedo. So Moog insisted it be purple. He later took Bowen to a Pink Floyd concert in Buffalo, at which the two marveled about how Moog's instruments were being used. But Bowen was more of a Keith Emerson fan. [151] Ill-advisedly, Norlin took over Moog's sales department, and Bowen was promptly fired. But one year later, when they realized the otherwise non-electronic company had nobody to demonstrate their instruments, he was called back and once again presented Moogs at the following NAMM show.[152]

While Bowen was working with Moog as a salesperson, Dave Luce was one of their product engineers. Luce was hired because he had built prototypes of synthesizers that could create realistic-sounding instrument patches. Luce's work eventually folded into the Polymoog, released in 1975. The instrument's design was more like an organ, with preset sounds and simple front-panel controls. Bowen became interested in Luce's designs, and started getting into programming voices. He also decided he needed a sequencer to augment his demos, so he sought out the two local companies at the time that might help: E-mu and Sequential Circuits. E-mu was more concerned with making sequencers for their own synthesizers, but they sent Bowen over to Dave Smith. Smith, who was just starting his company, had built a Model 600 Expander that Bowen snuck into Moog's NAMM demos. And soon, Smith himself was sneaking in, renting a hotel room that Bowen would detour Moog customers up into.[153]

Oberheim had a basic programmer for his 4-Voice that could store tuning, filters, and other simple parameters, and Bowen asked Smith if he could design something similar for the Minimoog. That product was the Model 700 programmer, but the Minimoog had to be modified in order for the two to function together. Again, Norlin abruptly decided to fire Bowen, but since he and Smith had been working so closely together, they partnered and showed Smith's programmer for the Minimoog, along with a new Model 800 sequencer running an E-mu modular synthesizer, at the next NAMM convention. This time, Bowen moved into front panel design, and friends Smith and Dave Rossum of E-mu started thinking about what to do next.[154]

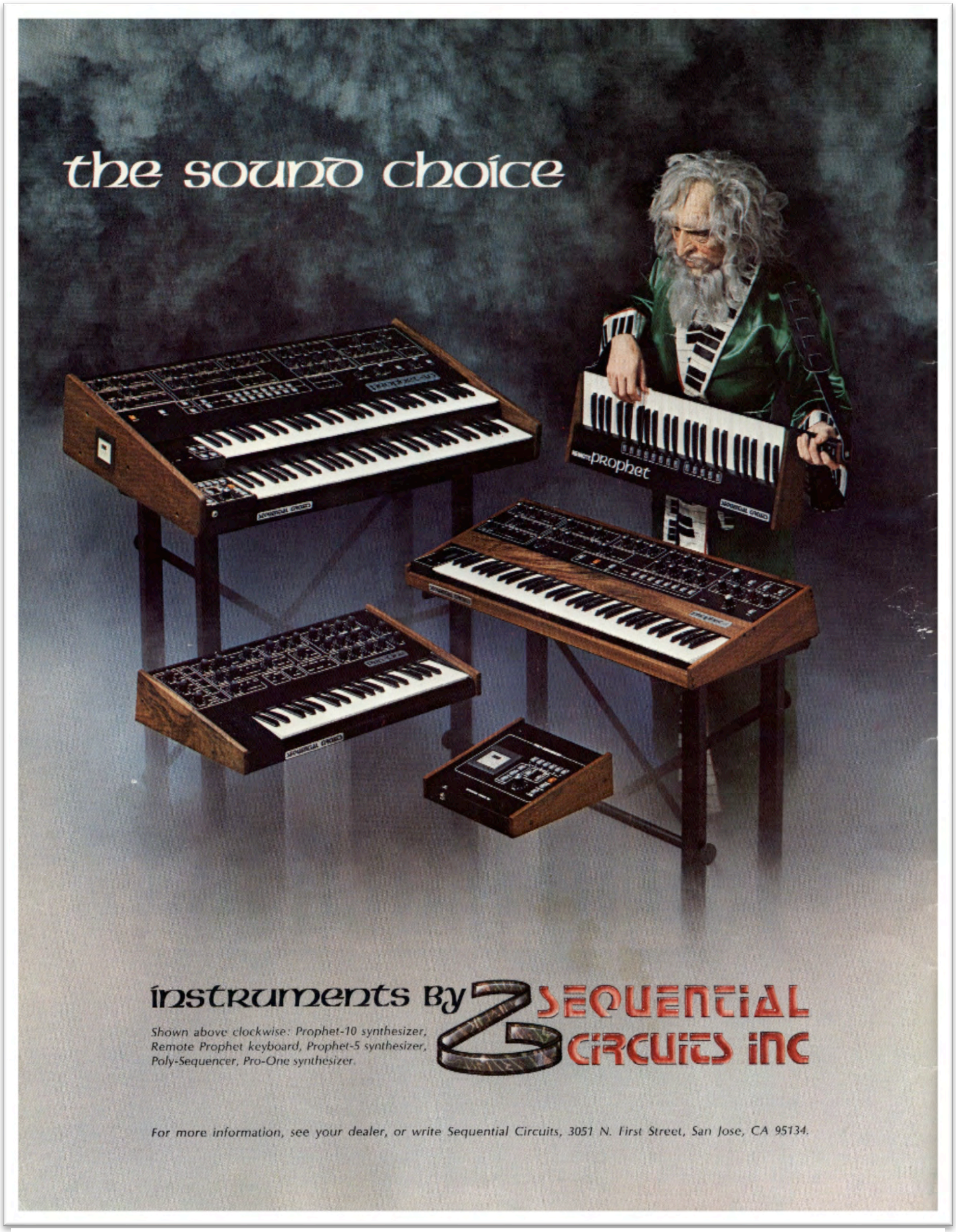


Figure 11: Sequential Circuits ecosystem, "The Patch" Newsletter, 1982. Brian Vincik Archives.

The Sequential Circuits Prophet 5 was unveiled at the NAMM show in January 1978. The Prophet was originally called the Model 1000, but Rick Wakeman, who was given a test run with one of the synths before it was announced, recommended Smith give it a name. It needed a personality. Suggestions included the Sorcerer and the Seer, but Prophet won out – the double meaning not lost on anyone. At the time of the NAMM show, Sequential barely had enough money to make the Prophet prototype; they were hoping to take down payments at the show, and build the units with the money they brought home. There was no price specified. But that seemed not to stop interest. The demonstration was packed with representatives from ARP, Casio, and Norlin looking on. Smith arrived late with the synth, and when he plugged it in, it was out of tune. So he sent Bowen off to quickly make some preset sounds, and the demonstration turned out to be an unexpected success for the small company – they received over 400 orders. In the time it took between clocking those orders at NAMM and the shipping date, the Prophet increased from $2995, to $3495, to $3995 – approaching the cost of a Honda. But Sequential Circuits was airborne, able to pay their bills, and Smith rewarded Bowen with 4% of the company.[155]

Smith finally offered Bowen a full-time position with Sequential, and he became the product specialist in charge of voicing, as well as doing all the trade show demonstrations. And Bowen got to use the opportunity to indulge his Prog and Fusion chops.[156] The Prophet 5 had space for 40 preset voices, divided into three banks: one for piano, organ, and other claviocentric staples; one for more synthetic tones; and a final batch of experimental and sound effects patches. Bowen and Smith were planning on leaving the third bank blank, in order to encourage users to program and store their own unique sounds, but there was a concern people might think the internal memory was broken. Devo engineer and Different Fur recording studio owner Pat Gleeson warned Bowen not to let Sequential sell his preset patches with the Prophet. Yet, when Bowen started hearing his preset sounds on the radio, in popular songs by artists like the Eurithmics and Phil Collins, he felt compensated in another way.

Just prior to Bowen coming on full time, Smith switched over from the SSM to CEM chips, and had him revoice the entire instrument for good measure. It is probable that this was a move to further distance the Prophet from the companies who were charging Smith licensing fees. Nonetheless, the competition was fierce, and not far behind: Korg brought out the Polysix in 1981, which sold for under $2000, replicating many of the Prophet's features, and putting a dent in sales. But by this time, talk at Sequential had turned to MIDI – although it was yet an interface with no name. Smith had already developed a sequencer that would control the Prophet, connected by a 4-pin screw-on DIN cable. ARP and Oberheim had their own sequencers, and Bowen heard tell that Japanese manufacturers were courting American companies that were working on digital interfaces. But the Americans could scarcely agree amongst themselves whose system should be the standard; they all had their own benefits and drawbacks. Ultimately, it was a presentation Smith made about his "Universal Musical Interface" that won Roland and Yamaha's confidence. The initial response was tepid from Smith's American contemporaries, but Bowen recalls that the Japanese companies ran faster with the idea of a multi-manufacturer interface than anyone had expected. Before he knew it, Smith was the reluctant voice of MIDI.

In early 1982, Smith returned to the drawing board and designed the Prophet 600, knowing that it would be Sequential's first MIDI-capable instrument. While Bowen was crafting the instrument's patches, he hooked two 600s together with one of them slightly detuned, and noticed the complex harmonics created just by layering one sound atop another. The pair produced timbres that could more easily be used to emulate the complexity of acoustic instrumental tones. The race was on to have units ready to deliver by December, and hold a formal release at the NAMM show in 1983. Smith knew that Roland would have their own MIDI-ready synth at the show, too. Bowen spent Christmas designing presets. At that first demonstration of MIDI, Bowen recalls Roland representatives carrying the JP-6 to Sequential Circuits' booth "over their heads, like a sacrifice."[157]

Bowen stuck with Sequential Circuits until 1987 when Yamaha bought the company. He helped develop the Prophet 3000 – a 16-bit digital sampler that did hard-disk recording, auto-looped samples, and had expandable memory. But there were financial problems brewing due to inexperience and mismanagement, and Bowen was unaware that Smith had plans to sell out. Otari, the tape recording company, was first in line. Once the staff found out about a possible takeover, many felt Otari would be a good parent company: they were not in the synthesizer-making business, so the hope was that most employees might keep their jobs. Yamaha seemed like a better fit to Smith. He was certain that the 3000 technology was the reason behind their interest. But when he went to Japan to tour the Yamaha facility, there were stacks of TX16Ws – Yamaha's new 12-bit digital sampler. Smith was left with enough parts to build 200 3000s. But it was not enough to keep the company afloat, and Sequential Circuits was forced to declare bankruptcy before the sale went through, so Yamaha would not inherit any potential legal claims. 70 employees lost their jobs, and Smith and Bowen went to work for Korg.

John Chowning and FM Synthesis

John Chowning is an American musician, engineer, and founding director of the Center for Computer Research in Music and Acoustics (CCRMA, pronounced 'karma') at Stanford University. In the late 1950s, Chowning was in Paris studying composition with the esteemed and influential conductor Nadia Boulanger. At the same time, Pierre Boulez, who was known as the *Enfant Terrible* of the Parisian avant-garde, and who would eventually found IRCAM, curated a series of concerts called Domaine Musicale, presenting performances by John Cage, Karlheinz Stockhausen, and other artists dabbling in electronic music at the academic level. With great interest, Chowning attended these nights, and began thinking about electric amplification as not just a means of making things louder, but as the canvas upon which to create new sounds.[158]

Chowning returned to the States in the 1960s, pursuing graduate study at Stanford, and becoming more fascinated with making music by unconventional, electronic means. He read an article in *Science* magazine, written by digital trailblazer Max Matthews, about his work at Bell Labs using computers to generate sound. Chowning visited Matthews in August 1964 and, as a parting gift, received a box full of circuit cards. He hired a fellow grad student to put them together, and began learning Fortran, the programming language. Chowning realized that, through working in the virtual, digital domain, one could build devices and route signals in ways that were far more multifarious than in the desert of the real. Rather than soldering and wiring oscillators and filters, signals could be generated, modulated, and manipulated inside a computer. Chowning immediately shifted the focus of his degree to computer music, and relied on the AI lab at Stanford to help him learn all he could about digital synthesis.[159]

Frequency modulation was more an auditory discovery of Chowning's, however, than via the mathematical language he crunched in the computer. He was experimenting with vibrato, a special kind of frequency modulation common in acoustic sounds like violin and voice, for example. Chowning realized that, working inside the virtual realm, the physical confines of instrumental vibrato could be disregarded – the computer did not care at what intervals or to what degree it modulated signal. He could fluctuate frequencies at greater depths, and faster rates, producing complex timbral changes that evolved over time, a lot like a pen-and-pencil instrument would. This was in contrast to the simple and uniform kinds of sounds – sine, square, sawtooth, &c. – analogue synthesizers were capable of producing at the time, which could be added to, subtracted from, and filtered to approximate the intricate temporal harmonics of acoustic instruments. Chowning doubled the number of oscillators, and discovered even more complexity in the computer's timbral signatures.[160]

He began making rudimentary compositions in the computer using software. Chowning applied the timbral blueprints of brass tones, whose high-frequency harmonics blossomed with increasing amplitude, and noticed that he could achieve with FM what Matthews was attempting with additive synthesis at Bell, but with much greater economy. Chowning worked on the computer's brass section, and produced some realistic sounding trumpet voices. He had already been in contact with Stanford's Office of Technology Licensing in 1971, for a system of spatial audio signal processing, which would position sound in three dimensions – a kind of quadrophonic prototype. So Chowning rang them up again, and Stanford took out the patent on FM. The OTL first contacted the companies it thought might be most interested in developing a new mode of synthesis: Lowrey, Wurlitzer, and Hammond. Each company sent out representatives in turn, but Chowning had a computer, not an organ, and spent a significant amount of time explaining to them how he was achieving sound from an immobile box, in the digital domain. Chowning was excited. They were impressed, but confused. Hammond showed the most curiosity, sending more engineers, then their vice president of engineering, and the organist Don Lewis, who was working on contract, to give an aural evaluation. Lewis raved about the uniqueness of FM's internal dynamism, but the organ company ultimately could not figure out what to do with digital synthesis technology. The OTL offered Hammond an option, and they declined.[161]

Deus Ex 7

Chowning and the OTL's director found out about another company, Yamaha, which was doing its own research into additive synthesis. In the early 1970s, Yamaha was getting back into the musical instrument manufacturing business, and had a small presence in the electric organ market, alongside Roland and the big American companies. The OTL contacted them, and Yamaha sent Kazukiyo Ishimura, a head engineer who later became president of the company. Ishimura was familiar with digital technologies; he knew how to program computers, and understood the significance of FM immediately. In 1974, Yamaha signed an option with Stanford, and knocked up a prototype a year later. One of its advantages was how FM synthesis dealt with foldover. To remove discordant upper harmonics of high frequency sounds, either complicated filtering mechanisms or waveform redefinition were necessary. FM rendered both of these processes easier, and digital technology made it faster and cheaper to accomplish. Between 1975 and '83, Chowning traveled back and forth to Japan about two dozen times, translating what he was doing into their keyboard devices – essentially helping Yamaha make digital FM synthesis patches for acoustic instruments that sounded just like the real thing. A team of engineers would surround Chowning as he described FM's theory, conjuring complex recipes for authentic instrument emulation.[162]

In 1983, Yamaha released the DX7, their third FM-based keyboard, and by far their most successful. The DX7 initiated near hysteria in the synthesizer business, and capitalized on a convergence of analogue and digital technologies, and unprecedented consumer interest in electronic musical instruments. Unlike the monstrous towering modular synthesizers of the early '70s, the DX7 could fit in the passenger seat of a car, and be carried under one arm. Priced below $2000, the machine contained three major innovations that led it to sell hundreds of thousands of units. The synth incorporated "aftertouch" sensitivity, which made for real-time control over timbral changes depending on how hard a key was sustained, and allowed synthesists to play expressively, beyond the capability of other more conventional keyboard instruments. One could, for example, control the speed and depth of vibrato on a violin patch by depressing a key with more force, "after touch."

Although the DX7 came with an extensive library of presets, it also had a removable cartridge that could save modified patches. This meant that a musician could carry his or her cartridge to any studio or gig with a DX7, plug in custom sounds, and play their own patches. These cartridges were soon replaced with more standard floppy disk drives, and became a common feature of digital synthesizers of the 1980s and early 90s. In October 1985, *AfterTouch* magazine became the official publication of the Yamaha Users Group, where DX7 owners could trade custom voice patches, as well as entire performance setups for the device, and most importantly for Yamaha, talk up their new gear.[163] MIDI was one of many significant reasons for the DX7's mammoth sales. Its implementation was last minute and slapdash (more on Yamaha's MIDI misinterpretation in Chapter 3), but the ability to network the instrument into and out from other synthesizers and computer sequencers doubtless contributed to its appeal in the marketplace, and vice versa. While Yamaha was not directly involved in developing the MIDI specification, or the ensuing discussions regarding its potential application, Yamaha's agreement early on to the MIDI spec with Roland, Sequential Circuits, et al., assured the keyboard's and the protocol's mutual adoption. The DX7 was so popular it redirected synthesizer development and design for the bulk of the industry, allowed Yamaha to buy out or otherwise muscle its competition, and even put other fledgling synthesizer companies directly out of commission.[164]

The swapability of preset sounds corresponds conceptually with MIDI's envisioned universality. Like a one-two punch, the DX7 and MIDI both helped to reorganize the structure of musical data, as well as reshaping innovation in music technologies more broadly, and altering the aesthetic qualities of music subsequently produced with them. A host of standardized peripheral gadgets – floppys, hard disks and other media, cables, patch bays and black boxes, outboard programmers, CD-ROM drives, &c. – cropped up to store, transfer, and support the growing data river created by the MIDI-capable DX7, and its host of offshoots and knockoffs. Beyond his development of FM synthesis, Chowning had little if anything to do with the DX7's development: the first time he ever saw one in action was in a local bar where he knew the keyboardist.[165] When it came time for Yamaha to test out their presets, they hired Don Lewis.[166]

The MIDI Patch Boys

Around the time Smith and Bowen were on their way over from Sequential Circuits to help conceive the Wavestation – an instrument released in 1990 that carried on in the sound design tradition of the Prophet line – Korg was in the process of developing something big. The company had just sold a majority of its share to Yamaha, who was supplying them with parts, and contributing to the cultivation of a new product line.[167] Korg was established as an organ and rhythm machine manufacturer by Tsutomu Katoh in Tokyo in the early 1960s, but unlike Roland founder Ikutaro Kakehashi, Katoh was content to be number two. He was more concerned with his personal happiness than with monetary success.[168] And his business strategy proved fruitful: he waited to see which products were in demand, allowing other companies to do all the expensive research and development work, and made less expensive versions of the more popular instruments. Korg also hired notable musicians like Rick Wakeman to consult on new products, and display their keyboards prominently onstage.[169] They were one of the companies involved in conferring MIDI in 1983, but Korg eventually reaped the benefits of insider status five years later with the M1, an affordable all-in-one synthesizer that outsold the DX7, and made Korg enough money to buy back their controlling share from Yamaha in the early 1990s.[170]

Unveiled in 1988, the M1 reflected an interesting intersection between the desires to create realistic sounding patches that emulated other sorts of instruments, and producing any blazing synth sound you can imagine. Korg's thinking at the time was, "why not both?" In fact, the M1 tried to do a little bit of everything: piano patches, drums, organs, and other synthesizers, strings, and effects. And although it did not make use of FM synthesis, employing the more simple subtractive method, the M1 was a veritable workstation that integrated a MIDI sequencer, onboard digital signal processors, and generated voices using the S&S method: combining samples of real sounds with oscillators to supplement them, synthetically speaking. American Korg engineers Jack Hotop and Jerry Kovarsky designed voices for the keyboard, along with a team known amongst themselves as the "MIDI Patch Boys."[171] Kovarsky, Korg's US product manager, came from Casio.

Figure 12: King Korg: The Polysix and M1 atop a Roland D-50 at the Museum of Making Music, Carlsbad, CA, March 2014.

He was the trade show demonstrator when MIDI hit, and was charged with showing the CT6000, Casio's first MIDI keyboard. Before coming to Korg, Kovarsky worked with a computer engineer called Roger Powell at Cherry Lane Technologies, getting up to speed on MIDI, and creating a software package called "Texture."[172] Hotop, Korg USA's senior voicing manager, was educated at the prestigious Boston School of Electronic Music in the 1970s, and started working with the company in 1983, helping to program patches for the Poly-800 – among Korg's first MIDI-capable synths. He voiced the DW series in 1985, which began using digital samples of single cycles of waveforms rather than create them with analogue oscillators – an innovation the M1 and its predecessors would take many steps further.

Prior to the M1, Korg's synthesizers, and the bulk of those coming from Japan, were shipped with different presets for different national markets: Japan had one set of presets; the US had another. But the sounds the MIDI Patch Boys designed were too valuable, and with the M1, presets became universal.[173] The way the keyboard produced sounds was thus: there were banks of real sounds – oboes, violins, brass, guitars, pianos – sampled digitally and stored in PCM format. Along with the samples, up to 16 digital oscillators could be used to augment and round out the sounds. As Hotop explains, digital samples took up significant amounts of memory (he describes sounds as either "memory pigs" or "little piglets"), so they were restricted in sample time to using, say, a short snip of the attack of a piano, filling its sustain out with digital synthesis. The MIDI Patch Boys were furthermore limited to a 32kHz sample rate in order to save additional space.[174] But new sounds could be added with expansion cards, and dumped from machine to machine, using System Exclusive MIDI information. The M1 provided the ability to layer eight of its patches at once, and economically produced some sophisticated synthesized sounds, with complex and resonant harmonics. Still, the patches the instrument was most known for were not wacky sound effects or madcap synths; they were its carefully crafted emulations of acoustic samples – the upfront organ and piano that defined 1990s House and Garage, and the snappy bass that gave the *Seinfeld* theme its slapstick.

Even Better Than the Real Thing

Companies invested significant time and effort into designing instrument patches. Bob Moog, who in 1987 worked for Kurzweil designing the K250, the first synthesizer to incorporate the S&S method, described their process of sound design:

> The software engineers who use our 'contoured sound modeling' programs to develop and compress sounds spend months on a given sound, months getting it to where it sounds suitable for playing on a keyboard, at all dynamic levels across the entire keyboard [...] We started off with recordings of grand piano sounds, but it's not the same grand piano. We actually picked one grand piano for the bass, another one for the mid-range, and a third one for the high end. We found what seemed to be a more even, richer range than we could have with any one of those alone. So that's the level we give to developing our sounds.[175]

It is clear from this account that the production of preset ROM patches, like those found on the K250 and later in the Korg M1, held real potential for claims to propriety, and posed genuine concerns for authorship and attribution.

Digital sampling opened up a legal can of worms that the 1984 American Federation of Musicians' case against Don Lewis only gestured towards. Camps were split between those who believed that synths and samplers would replace acoustic instrumentalists, and those who thought that digital tools like MIDI afforded more flexibility and control, thereby cultivating a more creative music-making environment.[176] Patches and sound libraries that were once obtained from hardware manufacturers and commercial suppliers became generated more and more via user production, and circulated through dedicated user groups. And this was more frequently taking place online, through systems like the Performing Artist's Network, which had dedicated groups making sounds for individual manufacturers, and trading MIDI files around the globe.[177]

Questions of authorship became central to discussions around digital sampling, and sound's digitization made samples all the more portable, and more difficult to trace. New musical technologies, and more importantly, what users did with them, had a profound bearing upon unionized musicians' status in the workplace, and in society more generally, by problematizing their rights to control their own work. Echoing AFoM President Fleischer's comments re Don Lewis, this implies that there was an ethical or "proper" way to use digital instruments in the musical community – a path that would exploit the capabilities of the technology without exploiting artists, talents, and instruments. But artists, being artists, tend to try thinking of every possible use for an instrument, intended and otherwise. In the mid-1980s, high-profile artists like Frank Zappa routinely held recording sessions, paying musicians hundreds of dollars to perform specifically for the purpose of building sample libraries.[178] Ironically, Zappa's 1986 album *Jazz From Hell* was among the first to contain the warning: "unauthorized reproduction/sampling is a violation of applicable laws and subject to criminal prosecution."[179] Synthesizers no longer merely emulated the sounds of real instruments; entire phrases of old recordings were increasingly being cut, copied, and pasted into new contexts. If synthesizers hinted at musicians' replacement by digital technology, sampling might have confirmed it.

These legal/creative difficulties were further illustrated by the unfettered proliferation during the 1980s of Phil Collins' snare drum sound, or the famous case involving Jazz drummer David Earle Johnson, who could convince neither Jan Hammer nor the AFoM to make financial restitution for surreptitiously made recordings of his rare Nigerian Conga drum sounds, which ended up punctuating the 1984 *Miami Vice* anthem.[180] Patches and presets like those designed by Moog for Kurzweil, Bowen for Sequential, and Hotop and Kovarsky for Korg – as well as the samples those sounds were based upon – were the intellectual property of the synthesizer manufacturers, but also thrived in popular recordings, user-generated reiterations, and imitations by other instrument companies.[181] The M1 piano patch arguably colored Rave music as much as the Amen Break characterized Jungle.[182]

Through patch-centric additions to the MIDI specification, like System Exclusive and Sample Data Dump, exchanging preset and modified sounds between machines became easier and more commonplace, and contributed to the conception of subsequent audio formats like the Audio Interchange File Format (AIFF) and the Waveform Audio File Format (WAV). Although MIDI contains no actual sounds, being rather the standard for the transfer of digital information about sound, the US Copyright office ruled in the late 1990s that Standard MIDI Files (SMFs) were subject to the same mechanical licensing laws as analogue or digital recorded media. In the eyes of the law, MIDI's "fixation of the performance" constitutes equivalence with records, CDs, cassette tapes, and even piano rolls, which are still subject to compulsory licensing provisions under Section 115 of the Copyright Act.[183]

MIDI had major ramifications for the way "real" sounds were subsequently performed and recorded – predominantly claviocentric in consequence. By dialing up a convincing-sounding sitar patch constructed through FM, or going further by sampling an actual sitar player, keyboardists could play any imaginable instrument by simply being able to manipulate a black and white piano keyboard. Synthesizers' velocity sensitivity, aftertouch, and other continuous controllers addressed the problem of emulating expressivity and real-time modulation like vibrato and pitch bend, and approximating instrumental idiosyncrasies with keyboard controllers. Sophisticated digital artists could conceivably orchestrate as many sound colors as their imaginations and budgets would permit, with no trace of traditional pen-and-pencil instruments, or the musicians to play them. The concept of MIDI "triggering" is important to think about, too: with moral ambivalence, MIDI data cares not for which sound or instrument it triggers. A musician could cycle through patches with the push of a front-panel button. Even towers of synthesizers, like those of Wakeman and Emerson, were no longer necessary; they were housed in single devices that stored hundreds of preset sounds. Hancock's current setup at the time of writing is a MIDI keyboard controller and a Mac laptop running virtual synthesis.[184] And Wakeman keeps his rig for visual effect only.[185]

As it became easier and easier for individual musicians to create entire MIDI symphonies, that is precisely what they did. No longer did orchestration rely on an actual orchestra. Nor did writing music any longer depend upon the social negotiation of songwriting teams, or the personal dynamics of bands. The 1980s witnessed the rise of the one-man band – each artist his (and her, but seldom her) own live electronic orchestra. Evidence of this can be found in the electronic theme music work from film and television by composers like Mike Post, Danny Elfman, Jan Hammer, Hans Zimmer, and Harold Faltermeyer, who could exert through technological mastery complete control over every compositional element of their scores. Popular producers, especially in the emerging genres of Hip-Hop and Dance music, were more frequently fitting the mold of the lone genius, and the concept of musical skill was itself turning more towards technological mastery than instrumental virtuosity. This is a corollary phenomenon to claviocentrism, which prizes the absolute superiority of the mastermind composer as the point of origin for musical creativity and control.[186]

In his article "Music Education and the New Media," scholar Bernd Enders argues that MIDI "unconsciously helped certain music structures prevail" and "contributed to the consolidation of certain aesthetic norms."[187] In many circumstances, rather than open up new fields of sonic exploration, standardization in music technology aesthetically homogenized characteristics of music – as was the case with the M1's House organ and piano patches – and encouraged a degree of structural homology. The MIDI Patch Boys' global batches of preset sounds littered popular Dance music recordings during the M1's heyday – from Robin S's "Show Me Love," to the Prodigy's "Your Love." The move to digital sampling furthermore created a rush to pepper every Hip-Hop track, from Public Enemy to Kool Moe Dee, with snippets of James Brown's extra-linguistic exaltations, and instigated reactions in the electronic musical community to the ubiquity of *uh's* and *huh's* with a Hat-Trick of Rave anthems released in 1991: LA Style's "James Brown is Dead," "James Brown is Still Alive" by Holy Noise, and Traumatic Stress's "Who the Fuck is James Brown?"

As Bryan Bell noted of early MIDI quantization, rhythm tracks with swing, or more intricate resolution than 24th notes, were outside the realm of possibility for most sequencers, making for stiff and rigid tempo structures.[188] Like presets themselves, electronic music was starting to sound generic – or, as Frank Zappa put it, “cheez-oid.”[189] And it was this uniformity in structure and aesthetics that arguably also led to the consolidation of the synthesizer business.[190] This seems to give weight to the technologically determinist argument of genre development in music, where music technologies drive innovations in musical styles and techniques. In the case of MIDI, technologies just as much circumscribed as unbound what was possible with them.

Conclusion

For years after MIDI became an integral part of the electronic music production process, a common way that people spoke about music technologies was how they spawned new ways of doing things, christened new genres, and new forms of music. Less has been said, however, about the genres, forms of music, and ways of doing things that seemed to spawn the technology. As much as various emergent electronic musical genres want to claim MIDI as their own, MIDI’s roots also stem from surprising fields of musical production, namely Jazz and Prog Rock. Keyboardists operating in these fields were interested in an interface that would give them the flexibility to play more than one instrument at a time, as well as to make touring easier and more affordable by compressing a number of instrument sounds into smaller and smaller devices. Synthesizers of the 1970s were large and impractically heavy instruments – cumbersome to cart around on the road. The ability to build synthesizers and other sound generators in rack-mount cases, playable by a single keyboard controller, became an attractive option, especially for musicians whose set-ups demanded a variety of simultaneously available instruments.

Professional musicians like Herbie Hancock, and synthesizer engineers such as Tom Oberheim and the fellows at E-mu, filled a vacuum of digital innovation in the mid 1970s left by American manufacturers struggling to differentiate themselves in the relatively small marketplace of analogue synthesis. Inter-manufacturer networking and compatibility were just not in the cards for companies like Moog and ARP. Conversely, NAMM and the Japanese manufacturers saw an opportunity to grow the whole industry by stimulating a standard that they could all nominally agree upon. But attempts, Stateside, to automate the production of music in any way received negative attention from professional instrumentalists and their union, the American Federation of Musicians.

Despite the union's objections, research continued at the academic level into ways of economically emulating acoustic instruments. John Chowning's work was steeped in the corporate-funded research of Max Matthews at Bell Labs, and formed the basis of several best-selling instruments, including the Yamaha DX7. In the case of E-mu and Sequential Circuits, technology licensing created a rift in a personal and professional relationship that crippled E-mu's success in the short term, and left their founders Dave Rossum and Scott Wedge out of the MIDI conversation altogether. Still, sound design dominated the agendas of synthesizer companies both before and after MIDI – but importantly, in different ways.

Presets primarily preoccupied pre-MIDI instrument development, whereas digital sampling and modified user patches took precedence in its aftermath. The law was in the favor of artists who claimed their recordings to be intellectual property, but the terrain around PCM samples incorporated into preset patches was muddier and more difficult to navigate. In other words, John Bowen had less of a claim to Phil Collins' "In the Air" synth pad, which used a Sequential Circuits-designed sound, as every band under the sun does against Girl Talk, aka Greg Gillis, who constructs his entire sound palette using samples of other artists' music. I argue that MIDI became "music" with the ability to copyright Standard MIDI Files, but there remains a rift between digital sampling and MIDI. Still, even though there is a big difference between a chintzy MIDI version of James Brown's "I got you (I Feel Good)" and a sample of the actual recording, the two are treated equally under copyright law.

In the end, however, everyone made out alright. Bryan Bell is president of Synth-Bank, a Seattle-based consulting firm specializing in music production and artist development.[191] Dave Rossum went to work for Creative Labs – the company that would release the enormously successful "Sound Blaster" sound cards for PCs, which dominated the computer music trade throughout the 1990s. Marco Alpert is a marketing guru at Antares, the creators of Auto-Tune. Sadly, cancer claimed Tsutomu Katoh in 2011, but Jerry Kovarsky still manages products for Korg, and Jack Hotop has been designing sounds with the company for over 30 years. John Bowen, Tom Oberheim, and Dave Smith all run their own successful boutique synthesizer houses, which produce updated retro versions of classic analogue designs – the hipster artisanal microbreweries of electronic synthesis. Perhaps it is his karma, but John Chowning is still emeritus faculty at Stanford's CCRMA Center.

In an uncanny turn of events, Don Lewis is currently a consultant at Roland Corporation. In April 2014, Keith Emerson received the honor of having a Moog modular synthesizer named after him.[192] And Rick Wakeman is on a very long and uncomfortably titled speaking tour, billed as "A Very Intimate Evening With Rick Wakeman," in which he regales audiences with tales of yonder rock-star-antic days.

As we will see in the coming chapter, all of the key players involved in MIDI were NAMM members, and the jovial tone of most of the oral history video interviews discussed above is evidence of the close-knit and fraternal community of instrument makers. The oral history program postures NAMM as the central and guiding force in the musical instrument industry, and the support NAMM's resource center receives from within the organization, as well as from industrial cooperation, is an indication to their presumed stewardship of musical instrument history. NAMM allows for an extraordinary amount of bravado and showmanship with the Oral History Program, encouraging its participants to wax poetic at length, telling as many old yarns as important or accurate recollections that may have some significance to media ecologists, communications scholars, and historians of technology. Nonetheless, NAMM provided the infrastructure necessary to bring together everyone in the electronic music products trade, and functioned as a sort of regulatory body in the absence of official MIDI oversight. In the next chapter, we will look at NAMM's organizational role in MIDI, and the other young associations that assembled around a discourse in digital instrument interfacing.

Chapter 3: MIDI By Association

Although standards are ubiquitous in the lives of everyday technologies – for instance, the number of frames per second displayed by a digital video format, or the samples per second of digital audio – establishing them can be tricky business. As Friedrich Kittler writes, "technical media don't arise out of human needs, as their current interpretation in terms of bodily prostheses has it, they follow each other in a rhythm of escalating strategic answers."[193] They are not adopted lightly; standards are most commonly arrived at discursively, negotiated through collaborative interaction, amongst interested but often competing parties, therefore inherently lending themselves to political posturing and maneuvering. Furthermore, once they are finally established, standards often require frequent updates, and necessitate auxiliary standards that form around them like scar tissue. In this way, standards become embedded; they are agentic; they exert material force in and on the world.

In their benchmark text on classification, Geoffrey Bowker and Susan Leigh Star define standards as "artifacts embodying moral and aesthetic choices that in turn craft people's identities, aspirations, and dignity,"[194] Paradoxically, through their efforts to create stability within a given industry, the actual people involved in establishing standards frequently destabilize commonly held assumptions and practices, as well as personal relationships and professional communities in the process. Obstacles are overcome, only to reveal new ones in wait; friends become enemies; adversaries get friendly. This chapter will examine some of the key individual and corporate players involved in encouraging agreement upon MIDI, as well as the myriad associations and organizations that were either instrumental to its creation, or emerged quickly afterwards to shore up MIDI's continued clout within the electronic musical instrument ecosystem. Standards have a manner of gravitational pull; they draw close objects into their orbit. Electronic instrument manufacturers and musicians were either pulled into MIDI's orbit, or risked being flung off into the void.

Standards and Classifications

Following Bowker and Star, it will now be useful to describe in detail what constitutes a standard, and how MIDI fits into, resists, or extends this definition. Generally speaking, a standard is "any set of agreed-upon rules for the production of (textual or material) objects."[195] According to a clear-eyed definition by synthesizer pioneer Bob Moog, MIDI is "the specification for a set of digital codes for transmitting music control and timing information in real time, and for the hardware interface through which the codes are transmitted."[196] The introduction of the MIDI specification was indeed a new set of rules: for the transfer of digital information between electronic instruments, computers, and tertiary devices; for the inclusion of hardware that would be necessary to implement MIDI; and implicitly, for the subsequent production of music that would utilize or rely upon MIDI's capabilities. New standards require new ways of conceiving and doing things.

Bowker and Star continue: "A standard spans more than one community of practice (or site of activity)."[197] MIDI was of keen interest to a constellation of communities, both embryonic and already existing; the synthesizer community in particular was a social cluster of creativity, and just as much a site for convergence and camaraderie as for exclusion. As we have seen, the analogue synthesizer making and playing communities of the 1960s and '70s were influential in forging MIDI for the interoperability of their instruments; but it was concurrently emerging computer users that in a sense conferred MIDI by embracing it almost immediately, and swiftly incorporating it into dedicated music related hardware and various kinds of software. Each of these heretofore discrete groups had different approaches to their respective disciplines: a musician might think of an instrument in terms of its compositional potential, whereas an electrical engineer may see the same instrument simply as circuits and wires. Did MIDI-based machines become more musical, or did electronic music making become more mechanical? The answer to both is yes.

The manufacturer associations, pseudo-regulatory bodies, points of contact, and interest and user groups that appeared as a result of MIDI meant the crossing of cultures; aesthetic and compositional principles bled into the thinking of engineers, and vice versa: musicians had also to adopt the mindset of a technician to make music with MIDI-compatible instruments. Collectivities of professional and amateur musicians, forums, magazines, and dedicated publications formed as a result of MIDI's adoption, but it will be equally important to closely examine the MIDI-related roles of trade and regulatory organizations such as the Audio Engineering Society (AES) and NAMM, which cultivated the space, time, money, and infrastructures for the idea of MIDI to comfortably gestate.

Bowker and Star state: "Standards are deployed in making things work together over distance and heterogeneous metrics."[198] On the surface, MIDI was designed to make control of remote instruments possible – onstage, in the studio, at home. But on another level, it was integral to MIDI's success to make sure that every instrument manufacturer – Japanese, American, European, &c. – implemented MIDI in a uniform way across their product lines, and observed a kind of stock execution of the standard itself. Otherwise, MIDI could not achieve the network universality its creators imagined, and promised. There were common misunderstandings about MIDI implementation, some of which will be discussed in this chapter, that created problems for various manufacturers early on. And so, people had to be put in charge of making MIDI make sense across languages, and among multifarious cultures.

"Legal bodies often enforce standards," Bowker and Star observe, "be these mandated by professional organizations, manufacturers' organizations, or the state."[199] As we shall see, MIDI constituted a kind of anti-standard in this respect: the specification was pushed through by a limited number of very influential keyboard manufacturers, without the official oversight or involvement of organizations like ANSI or the ISO. The creators of MIDI may have had the best intentions to make their standard official, but these regulatory bodies became more of an obstacle than MIDI's insurance – once manufacturers realized that they did not need governmental permission or authority to continue, the issue of formal standardization quietly became a distant memory.[200] Speed was key to MIDI's adoption. As an industry tipping point hastily approached with a necessary and sufficient number of early adopters, other former dissenters to MIDI were essentially forced to fall in line, or risk irrelevance in the new digital music making and networking landscape.

As Bowker and Star point out, "there is no natural law that the best standard shall win."[201] In many ways, MIDI's fast adoption and persistent survival was ensured by interventions from parties that were not necessarily interested in designing the best, fastest, most versatile, or most robust interfacing specification. As we saw in the previous chapter, MIDI's designers were focused more narrowly on strict and basic functionality rather than getting too fancy. Perhaps the most universal thing about MIDI was that everyone – manufacturers, musicians, designers, engineers, computer programmers, &c. – had to compromise in some way.

Bowker and Star say, "standards have significant inertia and can be very difficult and expensive to change."[202] This, potentially more than any other single reason, is what gave MIDI its longevity within industries that otherwise thrive on planned obsolescence and rapid turnover. In the process of offering solutions to simple problems, hosts of other more complex challenges are born. The subsequent solutions to these cascading problems further entrench standards like MIDI into architectures, infrastructures, and ecosystems. Here, it will be useful to track MIDI's "cumulative mess trajectory,"[203] or its cascading influence and embedding into practices and processes. Oftentimes, as one innovation is taken up, it amplifies and multiplies challenges in other, often unforeseen places. MIDI was no exception. The path towards MIDI was a contentious and contested one. Bowker and Star contend, "Whatever appears as universal or indeed standard, is the result of negotiations, organizational processes, and conflict."[204] It is those processes that will be of most interest to us in this chapter.

MIDI's Networked Publics: Social Construction of Technology

To trace the social construction of a given technology, it is integral to pay close attention to multivalent interactions between users, designers, and technologies. The SCOT method demands we attend to "how users consume, modify, domesticate, design, reconfigure, and resist technologies."[205] Technologies themselves do not determine their necessity, nor do users simply stimulate innovation through their desires and marketplace choices. Numerous inter-penetrable publics are responsible for bringing about technological change, and information flows asymmetrically through these various networks of feedback. In the case of music technologies, their adoption, use, and the consumption of music products that incorporate them occurs amongst highly specialized groups of people, with acute sets of skills, and who engage in singular kinds of cultural activity.

The driving ideology behind MIDI was to achieve a measure of consensus, with albeit limited opportunities for inclusiveness and dialogue. In the story of MIDI, a discrete group or association represented each of these factions, and the interaction between different MIDI-related actors reveals the vascular directions of agency and discourse in its development – where information and cooperation flowed freely, and where they were choked off. It is also important to understand that MIDI was conceived of and designed under the forces of capitalism, and recall the complicated politics that contributed to changing practices of mass-production in the growing field of musical instruments, more broadly. No doubt, manufacturers contributed more actively to MIDI than users. Still, the progressively escalating levels of attention paid to user communities by the manufacturing establishment after MIDI-related sales started to falter suggests the centrality of MIDI in a time and place of rapidly changing relationships between users and digital technologies.

It seems fitting that social networks are necessary to produce virtual networks. Professional associations, organizations, committees, and ad-hoc groups were integral camps within which MIDI was forged. Cumulatively, these associations constituted the conceptual field upon which MIDI's development played out. In the following, we shall examine the varying roles of the AES, NAMM, the MIDI Manufacturer's Association (MMA), the MIDI Users Group (MUG/IMUG/IMA), and in Japan, the Japanese Electronic Musical Instrument Association (JEMIA) and the Japanese MIDI Standards Committee (JMSC). Each of these organizations assumed a speaking role for their membership, and a more or less performative function in MIDI's ratification.

MIDI Stars in The NAMM Show

Undoubtedly, the most important organization that contributed to MIDI's development was NAMM – founded in New York at the dawn of the 20th century as a sales and trade organization representing fifty piano manufacturer members. At the time, pianos were just as central to Western music making traditions as they were to the music product industry; they were the largest selling amateur instruments in the US. A staple of concert halls, bourgeois homes, and natty saloons alike, increasing demand meant that there were a growing number of companies trying to build them as cheaply as possible. Knockoffs ran rampant, with some fly-by-night makers stamping the names of prestigious rivals on their counterfeit instruments.[206]

But pianos are, of course, finely tuned machines that require a great deal of skill and precision to make. When individuals started unwittingly returning these fugazis, or demanding repairs, instrument makers sought out an authentication process. And so NAMM was conceived of as both a retailer representative organization and a regulatory body of sorts, initially protecting and advancing piano makers' interests, but gradually encompassing the musical instrument business at large, while trying to appear publically to enforce certain standards of quality and transparency in production. Growing outward from its roots preventing the sham piano trade, NAMM eventually served also as a sort of standards agency for MIDI.

In those first years, NAMM inaugurated its annual trade show for new products in the musical instrument industry, and fast became the preeminent venue for unveiling innovations and new technologies in music making in the US. More than other sorts of consumer durables, musical instruments relied on demonstrative and interactive sales techniques that allowed potential buyers to see, hear, and try out the wares. NAMM shows, as they came to be known, were important buttressing points between heretofore disparate communities of engineers, designers, manufacturers, retailers, and high-profile musicians. And so, the yearly NAMM shows gained importance for cultivating associations amongst these agents, creating space for the cross-pollination of ideas through interdisciplinary dialogue and discourse.

NAMM continued to operate on the tautological rhetoric that music is of individual and social benefit – a universal right, not simply a privilege. While privately working to strengthen the business and increase the profitability of music products, NAMM publically sought to eliminate economic barriers preventing access to musical instruments through support of philanthropic pursuits and governmental lobbying efforts. In the proceeding decades, NAMM spread beyond its US borders, and expanded its mission to include support for music education programs, institutional and governmental lobbying efforts, funding academic studies on the importance and effect of making and listening to music, and actively increasing the number of music makers internationally. NAMM became involved with other more domestic kinds of organizations too, embedding itself within boys and girls clubs, teaching associations, non-profit music coalitions, magazines and publishers, and technology institutes.[207] These were precisely the kinds of organizations that were not particularly important to the development of MIDI, but a benevolent appearance helped NAMM assemble the right players to get the discussion in rolling.

NAMM imagined itself as part of a complete circuit, with its trade shows as the guiding force for funding and outreach, promoting the growing variety of musical instruments available, stimulating demand for those instruments, and increasing revenues for instrument makers and retailers, which in turn would be reinvested back into NAMM.[208] And because the Association was not in the business of actually making or selling anything, it could potentially facilitate situations in which collusion or even conspiracy might take place. To an extent, MIDI constitutes an example of this type of opportunity for conspiracy. Promoting MIDI was a way for NAMM to implicitly endorse specific products and companies, coming full-circle from its founding to generate large-scale profits by modulating cooperation and competition amongst its members.

Figure 13: John Bowen, Dan Ramsauer, and Dave Smith of Sequential Circuits, and Jim Mothersbaugh, and Yukio Tamada of Roland Corporation demonstrate MIDI at the 1983 NAMM show. MMA Archives.

MIDI was developed in the early 1980s by a group of five synthesizer manufacturers – Sequential Circuits, Roland, Yamaha, Korg, and Kawai – and quietly conferred at the 1983 NAMM show. In January of that year, MIDI's chief engineer Dave Smith of Sequential Circuits and engineer Jim Mothersbaugh of Roland US demonstrated a MIDI connection between a Sequential Prophet 600 and a Roland JP-6, a happening Bob Moog recorded in a 1986 article as taking place "without formality or ceremony."[209] MIDI may have been an informal and unceremonious mode of digital machine control, but the idea of it was contingent upon a protocological field of operation, where actions must be performed in the correct order, and where agency is decentralized and distributed within interconnected networks. It was brought about by a kind of obligatory cooperation, enforced by social rather than performative or legal edicts. MIDI was indeed co-constructed, but asymmetrically, by a limited number of conspirators, and for cross-purposes. Preliminary meetings at places like NAMM and the AES, and forums formed after MIDI was released, served simultaneously as open-system sites for input, as well as closure mechanisms that would progressively limit discussion, and help to swiftly stabilize MIDI as the standard digital interface for musical instruments.

Synthesizer Makers Unite! (Sort of)

MIDI meant different things to engineers, instrument designers, manufacturers, and players. Engineers and manufacturers knew what it could do; players knew what they thought it should do. Players had diverse ideas about what they wanted to be able to accomplish with MIDI's promise of universal compatibility, and what was intuitive to one person often appeared counterintuitive to another. Whether out of curiosity or animosity, the manufacturers' response to a user's suggestion was almost always "why would you want to do that?"[210] As we saw in Chapter 2, the people who coded MIDI did so with certain ideas in mind about how very specific kinds of music were made at the time, and influenced by that small group of musicians who wished they could do things differently. But the way MIDI ended up working for many amateur players was not how they thought it would, nor how it was first intended by the spec's developers.

For a decade prior to MIDI's conception, American companies like Moog, ARP, Sequential Circuits, and Oberheim had spent a lot of time and money designing and marketing their signature models of analogue synthesizers. From the Beatles and Pink Floyd to Stevie Wonder and Karen Carpenter, popular musicians were incorporating them into their works, and a growing number of amateur users wanted them too. The success of Wendy Carlos' late 1960s Grammy award-winning "Switched-On Bach" cycle of recordings legitimized synthesizers as instruments in the public consciousness.[211] But most would-be home players, whose jobs were not primarily in the music business, had trouble spending several thousand dollars on one instrument with relatively limited capabilities. Digital synthesizers were becoming much easier to make and cheaper to buy, and could be mass-produced quickly by well-established electronic manufacturing assembly lines overseas.

American synthesizers were so expensive because they required a lot of resources to assemble; they were made of costly materials, and far from being built of interchangeable parts on assembly lines, many companies operated locally out of apartments or garages. There was no "standard" way of making things. But the Japanese manufacturing sector had become so well streamlined – emerging from a period of exponential growth, manufacturing every manner of electronic communication device to supply the American military and civilian markets during the Vietnam War – that those American companies operating out of apartments and garages had no hope of keeping up.[212] And they knew it.

The idea for MIDI began taking shape in around 1981. At the Summer NAMM show, which was geared more toward industry meetings and research and development workshops than unveiling new products, synth maker Tom Oberheim approached Dave Smith, founder of Sequential Circuits, and casually mentioned that he had been asked by Ikutaro Kakehashi of Roland Corporation to think about designing a universal digital keyboard interface.[213] Both Smith and Oberheim had independently been developing their own proprietary interfaces. Armed with competitive interest from Sequential and Oberheim, Roland continued with its own development.[214] In October, the two Americans joined representatives from Roland, Yamaha, Korg, and Kawai for a preliminary meeting to talk about the possibilities of such an enterprise.

But the following month, Smith delivered a talk at the AES convention in New York about Sequential Circuits' USI concept (Universal Serial Interface), essentially describing what could be done musically with a high-speed serial interface. Smith's lecture generated colossal interest from his Japanese and American peers. Another meeting was called for the January 1982 NAMM Show, to which "about 10 or 15 companies" attended, including Moog and Fairlight.[215] This meeting revealed the wild variance of ideas that different companies held about what to do with a digital interface. But none of the American companies pushed forth with the idea, until the Japanese companies got back in touch with Smith later that year.

There was little to no consensus among the US-based manufacturers about what an interface should look like, and so Smith worked back and forth with Japanese designers, mostly housed at Roland.[216] From then on, it was a collaborative effort. Echoing that spirit, Roland proposed the name UMII or Universal Musical Instrument Interface, which would be pronounced "you-me." Smith countered with the Musical Instrument Digital Interface or MIDI, which still had a nice ring to it, and to his mind, more accurately described what the technology was for. By the end of 1982, Roland and Sequential Circuits had established a working version of the MIDI specification.[217]

E-mu and Sequential Circuits really began the push toward a kind of digital standardization in the 1970s by building microprocessors into their new synthesizers, and others in the US soon followed. But these early digital instruments could only interface with others made by the same manufacturer. Sequential Circuits had developed the "Universal Serial Interface" (USI) to operate between its own instruments, yet competition with the Japanese industry was too frightening to ignore, and Smith sought cooperation instead. By initiating and facilitating the MIDI specification with Roland, one of Japan's largest digital instrument makers, Smith and Sequential Circuits thought they were ensuring their own success in the American marketplace: if Roland signed on, perhaps Fairlight would too; if the Japanese manufacturers, otherwise considered heavyweight competition, needed to include American programming in their devices, surely musicians would continue buying Sequential Circuits gear as much as from any other maker. As we now know, this turned out badly for the Americans, with many of them losing their own companies, including Smith. Worse, some, like Oberheim, lost the rights to use their own names. At the time, however, US-based synthesizer makers believed participating in the MIDI discussion was the best way to leverage their own position within an increasingly globalized marketplace.

First Followers

Still, in 1983, MIDI was a ways away from being the standard it aimed to be. Any standard in formation is malleable to its nearest and most powerful forces. To become locked down – standardized – standards in formation require the perception of necessity, and at least broad consensus from concerned professionals. One way of manufacturing necessity is through evangelism; so getting manufacturers to consent to MIDI required not just early adopters, but well-positioned ones. On the US side, a handful of vocal agents emerged, arguing for the benefits of something that was risky business in a competitive industry: a universal rather than proprietary technology. For the sake of various interests, the first followers of MIDI worked hard, and mostly under unofficial auspices, to harmonize the electronic instrument business by bringing together American and Japanese companies, with radically different attitudes toward building musical machines.

In its conception stages, MIDI was kept as simple as possible. When two keyboards were connected via MIDI, one controlled the other – MIDI data flowed serially, in one direction, in a master/slave relationship. As a note was played on a master keyboard, another note would simultaneously sound on the slave device. When the master note stopped, so too would the slave note cease to sound. Of course, the "master/slave" terminology is deeply problematic, and reflects the ways MIDI's engineers were thinking about flows of information and control. More complications arose, however, between different instruments that were designed to do distinctive things. For example, if the master keyboard was touch-sensitive, but the slave was not, no amount of virtuosity would make the slave respond to touch like the master instrument. The same was true for other functions like pitch bend, velocity sensitivity, and polyphony. So, different MIDI messages had to be invented in a hurry, to allow for more sophisticated parameters.

At the same time, users placed increasingly elaborate demands upon manufacturers to expand the features and capabilities of their instruments. (This led to the development of keyboard workstations – instruments that crammed as many features as possible into one device – and also drove subsequent software development.) Each manufacturer had a slightly different way of implementing MIDI. For example, the interface was programmed to transmit on up to 16 discrete channels, which would operate in a similar way to tracks on an analogue mixer. But Yamaha's DX7 could only transmit on channel 1. And Roland, for instance, would not allow the reassignment of channel information. So, a Yamaha/Roland combination would only work on channel 1, preventing the use of MIDI's other 15 channels.[218] These early discrepancies expose the differing ways that instrument makers wanted MIDI to work, or not work, between rival-made machines. And the inconsistencies translated into user frustrations with not being able to do what they thought they could with MIDI.

It was necessary to get some musicians on board with MIDI early on – people who would tout MIDI's virtues rather than harp on its flaws. Most American synthesizer manufacturers were frustrated keyboard players themselves, who for one reason or another never pursued professional musicianship. For some, controlling MIDI from a technical perspective might have been a sort of substitution for being a virtuoso player.[219] For many, it was a way of marrying the science of engineering and technology with the freedom and artistry of making music.[220]

The MIDI Manufacturer's Association

In 1982, Jeff Rona was a struggling composer, who also worked for Roland US as the company's first American technology developer.[221] Rona contributed a column to Keyboard Magazine, and was a professional musician himself, but was more interested in digital technology, and specifically what computers and synthesizers could do together. Rona happened to be employed at Roland while the MIDI specification was being created behind closed doors with Dave Smith. As Rona recounts, MIDI was a well-guarded secret before it was officially unveiled, in part because both Roland and Sequential Circuits had MIDI-ready keyboards poised to enter the marketplace.[222] After being shown an early MIDI prototype, he was told, "You can't talk about this but we're going to focus a lot of energy on this; we're not sure to what end, but this is going to be a very important thing."[223] Rona was charged with directing all his energies into thinking of possibilities for MIDI, and later programmed the synth maker's first MIDI sequencer for an Apple II. The January 1983 unveiling of MIDI at NAMM was a low-profile affair, and a private supplemental seminar assembling interested parties took place during that show to determine the immediate course for MIDI. Tom Oberheim was the ad hoc committee's first chairperson, but quickly relinquished that role. When nobody else volunteered, Roland's inside man Jeff Rona was co-opted to head the MIDI Manufacturer's Association.[224] The MMA was a self-appointed association to a certain extent, but one that was tolerated due to the perceived necessity of cementing MIDI as the de facto digital interface.

Figure 14: The "World of Roland" exhibit, NAMM Chicago, 1987. Trond Bratten Archives.

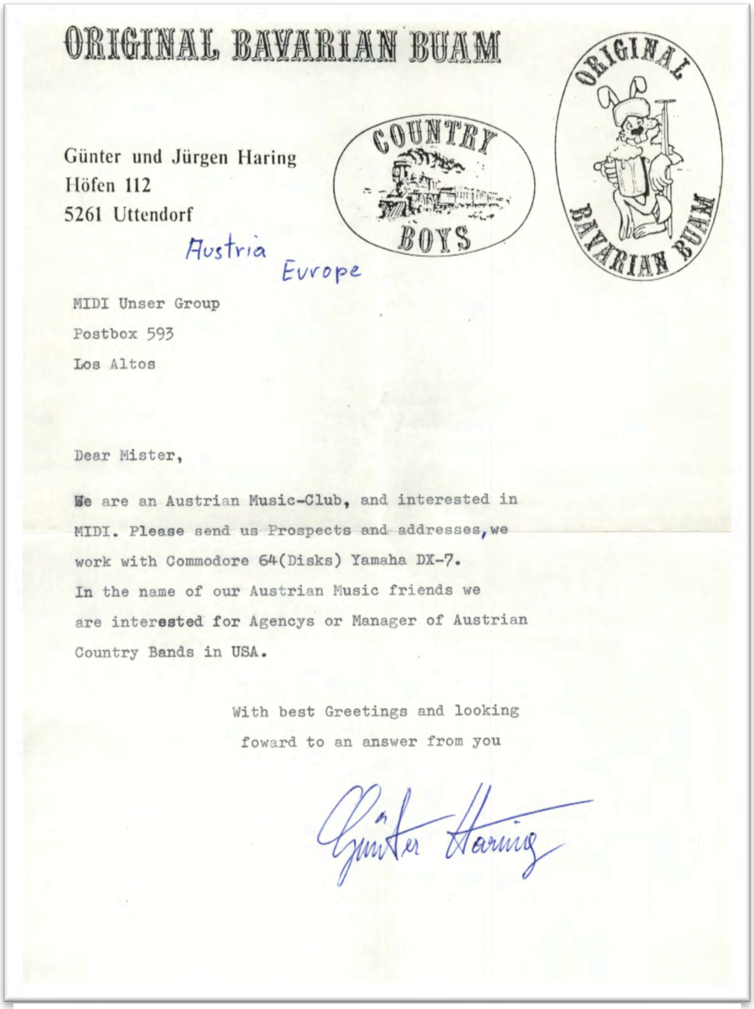
Under Rona's direction, the MMA became the focal point for information about the MIDI specification for any company wanting to incorporate it into their instruments. At the summer 1983 NAMM show in New Orleans, Rona booked a conference room and invited as many people as he could imagine who might have some interest in MIDI. Hundreds attended, and as Rona notes, there were some dissenters. But once Roland and Yamaha agreed to include MIDI in their forthcoming instruments, all other manufacturers fell in line. He described Roland and Yamaha's presence as "a bit of an 800-pound gorilla, but in the nicest possible way."[225] At the following NAMM show in winter 1984, Yamaha introduced the MIDI-compatible DX7, Casio unveiled a range of inexpensive digital keyboards, and Roland released its JP-X, all of which would prove immensely popular instruments. Henceforth, the MIDI spec would be given by the MMA to anyone interested in making it part of their instrument, for the price of the paper it was printed on.[226]

The International MIDI Association

Figure 15: Pun-laden button given to IMA members, NAMM 1984. Brian Vincik Archives.

Concurrently with the MMA's formation, the International MIDI Association (IMA) was also coming together as a loose-knit user-driven organization, under the direction of Brian Vincik, a Hewlett Packard engineer with friendly ties to John Bowen at Sequential Circuits, Prophet-5 expert Roger Clay, Lachlan "Lucky" Westfall, and others. Initially named the MIDI User's Group, then the International MIDI User Group, and briefly MUSE, or the MIDI User's Support Exchange, the IMA at first assumed it was responsible for many of the same roles as the MMA: ostensibly, to make various and disparate parties agree to the MIDI spec; to distribute information to manufacturers about designing MIDI into their instruments; and to be the lightning rod for questions from curious end users of MIDI-capable products. But the IMA would prove more important to MIDI's adoption by the computer business.

Within months of MIDI's inauguration, hundreds of letters from North America, Japan, and Europe started arriving to Sequential Circuits, requesting information on MIDI. Everyone – from major manufacturers to Bavarian beer bands, from universities to schools to government agencies – was curious. But after feverishly developing the MIDI 1.0 spec simultaneously with his own MIDI-capable instrument, Dave Smith wanted to focus first on filling orders, and then on designing and building the new models he would need to stay competitive with the companies that were fast adopting MIDI. The volume of correspondence, and the tedious work



ORIGINAL BAVARIAN BUAM

COUNTRY BOYS

ORIGINAL BAVARIAN BUAM

Günter und Jürgen Haring
Höfen 112
5261 Uttendorf
Austria
Europe

MIDI Unser Group
Postbox 593
Los Altos

Dear Mister,

We are an Austrian Music-Club, and interested in MIDI. Please send us Prospects and addresses, we work with Commodore 64(Disks) Yamaha DX-7. In the name of our Austrian Music friends we are interested for Agencys or Manager of Austrian Country Bands in USA.

With best Greetings and looking foward to an answer from you

Günter Haring

Figure 16: IMA correspondence, Brian Vincik Archives.

of keeping track of manufacturers, quickly frustrated Smith – not to mention the prospects of copyrighting the spec, negotiating the incorporation of new kinds of MIDI data, and tending to other administrative kinds of duties. And so others stepped in.

Brian Vincik was a California Polytechnic-trained engineer whose first job was for Hughes Aircraft, working on a wire-guided missile system.[227] In the late 1970s, his interest in music would bring him to the Bay Area where he became friendly with John Bowen, an amateur musician and instrument retailer who designed sounds for Sequential Circuits' synthesizers. Vincik foresaw potential in interfacing keyboards made by multiple manufacturers, but especially amongst keyboards and computer sequencers. Vincik worked for Hewlett Packard, and brought them the preliminary idea for MIDI, but they did not initially see any value in incorporating a digital networking standard for making music with synthesizers. Hewlett Packard was in the business of designing and making computers for government and business, not for artists and musicians. Others though, including Apple and Atari, were interested. In March 1983, Vincik registered the futuristic-sounding and all-encompassing "Digital Concepts" name with Mark Mortarotti, intending to legally copyright and standardize the MIDI spec with the US patent's office and ANSI. In August, the pair incorporated the "MIDI Users Group" out of Vincik's Cupertino, California, residence with the vague intention of being the mutually agreed-upon keeper of the spec, and set to work building and maintaining a core community of everyone from multi-million dollar music corporations, hobbyists, government bureaucrats, future rock stars, and most importantly, computer people.[228]

During the same formative months, part-time keyboard player Roger Clay had been making steps towards establishing user groups for the Rhodes Chroma and Prophet 5 synthesizer. Although he was an enthusiast and not an engineer, Clay was passionate about electronic musical instruments' digital potential, and foresaw the buttressing of music, computers, and telephonic networking technologies in ways that had not previously been conceived. In a February 1984 interview, Clay imagined "classrooms without walls," where "a teacher in Los Angeles could be teaching a number of students all over the LA area without requiring them to come to his studio, utilizing modems or some sort of other telecommunications system."[229] This was a leap from Smith and Roland's idea of the spec, and reflects how varying notions and opinions were at the time.

Vincik and Clay saw eye-to-eye on MIDI's networked future with computers, and the MIDI Users Group became the IMA, a non-profit corporation, nonetheless with Clay approaching evangelism in his editorials for the IMA Bulletin. In its inaugural issue, Clay delivered a sweeping statement of principles: "Accurate information and helpful advice on products and resources are important to any creative process. In the new world of musical equipment/ equipment interfacing (let's call this *musical cybernetics*) they become essential services"[230] (emphasis in original). In addition to the MIDI spec, the IMA would provide that service to its members by setting up seminars and conferences at NAMM and other trade shows, for the price of an IMA membership (about $300). Because the MMA only accepted manufacturer membership, the IMA would continue as the only officially recognized user-driven MIDI association.

Imagined Applications

Some musicians imagined MIDI would work in very simple applications, from one instrument to another. If a keyboard player wanted to layer two different instrument sounds together, and have one precisely follow the melody of the other, there was no longer a need to play the same phrase twice, or with two hands simultaneously. Other musicians with more extensive instrument collections realized that they could "daisy chain" several devices, and layer a handful of sounds together, essentially making a multi-timbral multi-manufacturer instrument with a MIDI cable and some elementary technical setup. Others still, like Herbie Hancock, for instance, imagined stacks of instruments in rack-mount cases, each triggered by a single MIDI keyboard controller.

Still other artists who were dabbling in computer code conceived of one or several instruments being played by the software on a single machine. Some professionals saw MIDI as potential competition for media themselves, as talk of the "tapeless studio" began to circulate.[231] Recording and storing sequences on a device with digital memory meant performances could be precisely repeated over and over again, without costly analogue recording equipment. Because MIDI's data were small and simple, entire recordings could be miniaturized and stored as MIDI files on a few floppy disks rather than reels and reels of tape. As memory became greater in capacity, smaller in size, and more affordable, digital signal processing meant the tapeless studio would take on another meaning, as we shall see in the next chapter.

The development of MIDI was centered geographically in Silicon Valley, just on the cusp of an explosion in digital technological innovation. But personal computers were still out of reach, both price and technology-wise, and only those few in cutting-edge industries embraced digital forms of communication. Consequently, most correspondence took the form of written letters, many of which began multiplying at the IMA's Los Altos, California headquarters. That level of interest from the novelty-hungry user community would speed up what some felt was MIDI's premature stabilization in the industry. Musicians were already starting to conceive of and trying to use MIDI in unforeseen ways, and they had questions. Still, the tone of even the most confused user was usually more cordial than correspondence amongst manufacturers. In a letter dated September 15, 1983, from Bob Moog to the MIDI User's Group, Moog writes: "If you want to send me a detailed reply telling me where you guys are 'at', I'll do what I can to work it into my

Keyboard magazine column. But please, no bullshit, O.K.?"[232] Given the industry hype and hyperactivity around MIDI at the time, "bullshit" was precisely what he was expecting.

MIDI Drift: Miscommunication and Messes, Accumulated

Language was often a barrier to MIDI's smooth operation, particularly between the American and Japanese instrument manufacturers. And even though MIDI was intended to be a universal machine language, its implementation was frequently lost in translation. Differing notions about what MIDI should be, and what it should be able to do, abounded between company lines, different generations, and across national borders. Miscommunications proliferated further when the MIDI specification was translated back and forth between English and Japanese. In the first version of the specification, MIDI was programmed in three modes: Omni, Poly, and Mono. In Omni mode, an instrument would act on information sent over any MIDI channel; in Poly mode, a device would transmit and receive only on one designated channel; in Mono mode, each discrete voice within an instrument could be programmed to receive over a separate channel. Understandably, Yamaha's engineers thought that Mono meant "monophonic" – as opposed to polyphonic – and programmed that mode to read any incoming channel information through a single voice. Subsequently, Mono became known perhaps even more strangely as "Poly" mode, but not before Yamaha had accidentally coded and implemented its own proprietary MIDI addendum based on misinterpretation.[233]

Differences in user expectations surfaced elsewhere too, for instance, in discussions about MIDI's baud rate – the time it takes to move data from one device to another. This can be thought of as a standard within a standard, a cascading consequence of MIDI. Unlike other kinds of digital data, which could be forgiven for taking awhile to transfer, MIDI had to transfer highly time-contingent musical data. The perception of simultaneity was among the most important factors for MIDI's programmers to get right: a note performed on device X must immediately trigger device Y, not seconds or even fractions of a second later. MIDI's baud rate was set at 32k, or 32,000 bits per second.[234]

For some musicians, this seemed sufficient at the time, but for professionals, and those coming from computer-related fields, MIDI appeared painfully slow in comparison to other emerging standards for digital data. By 1984, Apple's new Macintosh computer boasted a baud rate of 1 million bits per second; MIDI's serial interface was additionally considered inferior to parallel networks, which could transfer more data at once.[235] Debate around MIDI's baud rate and whether or not it should be accelerated revealed differing assumptions between musical and technological-minded users. There was already consensus growing among the synthesizer manufacturing community that digital technological advances were happening too quickly, and multiplying problems with MIDI's compatibility. As Dave Smith warned in Dominic Milano's benchmark article, "it's going to get more complicated before it gets less complicated."[236] Standardizing MIDI's baud rate was one way to put the kybosh on at least one obstacle.

For professional musicians, and those in the synthesizer design industry, baud rate was less of an issue than MIDI's resolution: how it separated analogue information into 256 discrete values. The ways that individual instruments handled continuous modulations varied widely, and implementing them via MIDI system exclusive data varied even more. Sending, say, pitch bend information across instruments that allowed for multiple octaves rather than semitones, sometimes produced unexpended results. Instead of a smooth sweep in frequency, the tone skipped from step to step. This contributed to disdain for MIDI from companies like Moog, E-mu, Buchla, Oberheim, and players like Morton Subotnik who strove for microtonal and microtimbral variation. Using MIDI, digital instruments could scarcely mimic the intricacies of analogue modulation with control voltage or gates. "My analogue sequencer makes unique sounds you can't get from digital sequencers," said Trevor Pinch in our interview around MIDI's 30th anniversary. "This partly explains the return to analogue sounds and controllers today."[237] Years of development and fine-tuning by instrument makers, to give their machines distinctive characteristics and sounds, were being leveled by an interface that discarded a lot of highly specific or in-between information for the sake of simplicity. It would still take several years for highly detailed MIDI data to become a core component on the majority of digital instruments.

The MEC and IRCAM

On January 22nd 1984, a mere year after MIDI had been officially introduced to the public, the IMA held a manufacturer's conference at the NAMM Show in

Anaheim, and entrenched a group called the MIDI Evolutionary Committee (MEC) to determine the course for the specification. The group was nominated and elected by those in attendance, and included Bob Moog, John Bowen of Sequential Circuits, private software developer Curt Simmons, Yamaha digital products specialist Jim Smerdel, Linn electronics alum and Oberheim engineer Anne Graham, European representative and IRCAM member Antoine Cuvelier, Brian Vincik, and Roger Clay acting as committee director. Dave Smith's name is notably absent.[238]

The MEC's goal was to officially standardize MIDI, while retaining the conversational open-forum ethos that had brought MIDI from talk to reality. In a March 3rd email, Smirdel proposed further discussion on the qualifications for voting privileges within the MEC, and suggested that it be composed solely of people who were currently making MIDI-capable products.[239] This would ostensibly ensure that only those with a direct interest in steering MIDI for the common cause be in an executive decision-making position; it also forced a kind of with-us-or-against-us mentality both inside and outside the MEC, which ultimately made MIDI all the more visible as the official standard for networking digital instruments.

Having an in at places like IRCAM led to MIDI's infiltration into that obscure but influential French organization and others like it, and past the hostility towards personal computers that some of its high-ranking members curiously held at the time. But experimental and educational institutions were not on the top of the IMA's recruitment list per se, nor were they particularly good for manufacturers, from which their officials and faculty often expected discounted or free products. Additionally, the attitude within musical academe was unfavorable toward emerging digital developments from parallel or outside the traditional musical instrument industry, and especially so at IRCAM.

Musicologist Georgina Born notes that artistic director Pierre Boulez "actively despised small machines" (leaving it unclear whether the object of his derision was the machine itself, or its diminutive size), and said that Mac computers would come into IRCAM "over his dead body."[240] But in 1984, in they came – six of them – along with as many Yamaha DX7s. Here, a mutually beneficial arrangement was struck: IRCAM would receive the technology at no cost (they even hired an unpaid intern, a staple in corporate pragmatism, to install it for them) and Apple computer would retain "some rights over software developed on and for it."[241] Ultimately, the computer industry would benefit immensely more from handshake deals like this, through direct development and future conscription.

MIDISoft '84

Another important step taken toward broadening digital industries' and MIDI's involvement was the IMA-sponsored MIDISoft '84 conference, which took place over two days in late May at the Mark Hopkins Hotel, San Francisco. One part trade show, one part IMA committee recruitment meeting, MIDISoft was arranged to establish a MIDI software standards board, and to create a professional networking space for software developers and users. In order to ensure MIDI's longevity, it was in the IMA's interest to position itself in the middle of this conversation, and centrally within the computer and digital music ecosystem.

Computer guru Jaron Lanier and Alan Marr of LucasFilm were among the event's keynote speakers. Upon the brochure was written with brazen confidence, "This could be the single most important conference in the history of the evolution of music."[242] But all was not right in MIDI-land, and fissures were revealing themselves. When several hundred participants from widely varied backgrounds began talking about developing software standards, it became clear that several prerequisite issues needed to be addressed. It bears repeating that MIDI was not officially a standard; many people wanted to know if it would become one, and if not, what the implications would be. Complicating matters, many of MIDI's original engineers, including Dave Smith, were not present at MIDISoft, leaving participants to question the authority of a standards board composed without them.

Gareth Loy, then a Software Coordinator with the Computer Audio Laboratory at UC San Diego, was put in charge with corralling this unruly meeting. He suggested they divide and subdivide issues into more manageable goals – those that needed to happen immediately, and others that could wait for the near or distant future. Using the Institute of Electrical and Electronics Engineers' model of Special Interest Groups (SIGs), he then proposed several subheadings that could further narrow their purview.

First, and of foremost concern, was the special interest group charged to resolve incompatibilities and contradictions in current MIDI usage. The idea of MIDI universality had reached necessary and sufficient agreement within the various communities represented, and there was a sense that MIDI's promise would go unfulfilled should it not achieve unanimous acceptance. Next, a group was created to cover omissions. This SIG would address more player-oriented concerns such as expressivity, sensitivity, and after-touch. Another SIG focused on the future of MIDI, including "Baud rate, code precision, additional codes, MIDI as Local Area Network, development of MIDI as a layered standard similar to the Ethernet standard, proposal of MIDI standard to ANSI and ISO, etc."[243] Another was in charge of communicating exclusively with Japanese manufacturers (as we shall see, Japanese companies had their own MIDI-related associations that were concurrently forming). An SIG was formed exclusively for MIDI manufacturers; and finally, an omnipotent SIG was established to oversee all the other SIGs, ensuring smooth operation within and amongst them.

Almost every group established at MIDISoft had members from both the musical instrument and synthesizer manufacturing community, as well as someone positioned within computer hardware and software development. As MIDI and the computer industry moved into the same terrain, intersecting interest from both camps was mounting: suddenly, musicians needed to know about what computers could do, and an emerging bloc of PC retailers wanted in on MIDI. The event at times came off like a pyramid scheme pitch, as when Clay advised, "the best thing a retailer can do at this time is establish a rapport with a nearby computer store, but with the realization that in the future, they may want to be a computer store themselves."[244] But by the 1987 NAMM show in Chicago, Clay's prognosis proved correct: computers were everywhere in the musical instrument business. Apple had its own elaborate booth, and anything involving MIDI – including keyboards, drum and wind controllers, score-printing software, and early steps toward graphically oriented digital editing – was attached to, or performed onscreen, with a PC. To a large extent, computers were at NAMM because of MIDI, but MIDI was just as dependent upon computer companies, and equally if not more upon users programming software that accepted and respected MIDI's stance as a standard.

Figure 17: Digital Creativity: The Apple Computer booth, NAMM Chicago, 1987. Trond Bratten Archives.

MIDI, the Anti-Standard

The IMA was fast realizing that trying to standardize the spec, to go through ANSI, to wade through the canvassing process and the literature, would take far too much time – many years rather than the days and months things had taken until then. In 1984, MIDI In, Out, and often Thru ports were already coming installed in the world's most commonly sold keyboards, MIDI patch bays and other black box gear were becoming more and more popular, and MIDI was entering into the very architecture of instruments as varied as jukeboxes and church organs. Even things that did not require MIDI included it. This is evidence of MIDI's agentic role in the music products industry, as well as proof of its cascading cumulative mess trajectory – a trajectory that was already too far along in its arc to change course. MMA chairman Jeff Rona recalls looking into the standards literature and realizing that MIDI was already too entrenched in the electronic instrument industry to officially standardize.[245] The IMA arrived at the same conclusion several times over; in their archives are all the necessary legal forms, partly filled out, but never properly filed. Within a year, and without officially standardizing with a governing body, MIDI had in effect become an official standard, unofficially.

Because the IMA had joined ANSI, MIDI was on their radar, even though it would have taken a push from the IMA and not ANSI to make MIDI standard.[246] ANSI is not a policing organization, seeking out unstandardized common practices; rather, they are a rigorous but voluntary regulatory body. Still, ANSI did invest some thought into MIDI, and imagined its own applications for digital musical data. In 1985, ANSI's properly space-age-sounding X3V1 task group on Text Description and Processing Languages convened a study on how to cross-apply musical information and data processing. The research was conducted under the auspices of the Musical Information Processing Study Group at IBM Research Laboratory in San Jose, California, over two days in May. In its call for participants, the X3V1 proposes: "The committee believes that effective realization of [MIDI's] potential requires musical interchange and processing standards that will integrate musical data into the mainstream of information processing. Device control coding protocols, such as

MIDI, do not address this objective."[247] To the task group, it seemed that music was potentially just another form of data entry – a perspective that would obviously not interest MIDI's core manufacturing community, who were having enough problems implementing the spec while still trying to design next year's product lines.

As a result, no single person or company or even professional organization actually has ownership over the spec. Once it infiltrated the relatively small world of electronic musical instruments, and spread into the still small but rapidly expanding universe of personal computers, MIDI was embedded sufficiently to be a de facto standard, without being a legally regulated classification. Rona claims that the fact MIDI was never branded as a product is the reason why there was no official MIDI logo or font – these things were extraneous to what MIDI meant to the engineers who programmed it, and the droves of musicians keen on making their music studios MIDI-compatible.[248] The focus was shifting from what MIDI was to what it could do – in the studio, and the marketplace.

JEMIA and the JMSC

Associational notions were different in Japan. For one thing, Japanese manufacturers were less interested in allowing users to have their say in any kind of organization that concerned updating or altering the MIDI spec. There was no Japanese equivalent of the IMA, and professional associations still called the shots. The Japan Electronic Musical Instrument Association (JEMIA) was the Japanese answer to NAMM, but oriented specifically toward electronic instruments. Since the 1950s, electric organs had become a social phenomenon in Japan, a staple of homes and bars, and big business to companies like Roland and Yamaha. These two in particular had vested interests in MIDI because of their own in-house advancements in digital technology: Roland with its Jupiter models, and Yamaha with the DX series.

JEMIA was responsible for ensuring that Japanese instrument manufacturers complied with individual national standards councils, like ANSI in the US, and the CSA in Canada; but it was not in the business of developing or maintaining standards themselves. So the Japan MIDI Standards Committee (JMSC) was formed as an arms-length organization within JEMIA on June 29th 1983, initially to assign independent MIDI ID numbers to manufacturers.[249] If JEMIA was responsible for such a task, it might have appeared as a conflict of interest within a presumably objective commission. But the two organizations occupied the same office; the same secretary answered their phone calls.[250]

Another reason why the IMA may have abandoned the notion of trademarking MIDI was that the JMSC had already thought of it. However, this was not for monetary gain; it was strictly so that rogue manufacturers could not use the term "MIDI" if they were not actually using MIDI. By October 1983, the Japan MIDI Standards Committee collected dues from 28 manufacturers and 24 private members, and had already distributed a Japanese version of the MIDI 1.0 specification to all of them. The secret was out. In a letter from the JMSC's chairman Mitsuo Matsuki to Clay and the IMA, the objective of keeping MIDI essentially free to the public was its stated first priority.[251] Matsuki believed in no uncertain terms that the IMA should be consulted on any future modification or change of MIDI, but specified that these kinds of considerations take place "as quickly as possible".[252] It was obvious to the Japanese that the MMA and not the IMA was the JMSC's US equivalent. And from then on, Haruo Noriyasu, executive director at Roland Corporation and JMSC's secretary in general, was delegated to corresponding with the IMA. For Matsuki, MIDI was already made.

In late November 1983, the JMSC appointed Noriyasu as its chairman, and organized its own Standard Investigating Commission, under the charge of Katsuhiko Hirano of Nippon Gakki.[253] It consisted of seven manufacturers and two computer magazines, which took responsibility for assigning system exclusive information such as ID numbers, as well as for explaining MIDI in common language for operation manuals and trade journals. Noriyasu soon figured out that Clay was not coming to MIDI from the technical side of things; he was unfamiliar with hexadecimal notation, for instance. Noriyasu was a Roland engineer, and as far as they could tell, Clay was a keyboard player, and gung-ho editor for the IMA bulletin. Noriyasu also had to explain to Clay that the JMSC was unlike the IMA in one key way: information on MIDI was already freely circulating amongst users in Japan, and any kind of IMA membership fees or bulletins would likely enjoy little demand. This was a gentle reminder that the JMSC was really only interested in working MIDI's core technologies into new instruments, and not maintaining a US-style user group. Effectively, users became the IMA's charge.

Publications

MIDI's furious development and adoption fuelled a spate of related publications. As word of MIDI spread, musicians' and computer magazines, how-to books, trade papers, bulletins, manuals, industry pamphlets, and advertisements proliferated because of a new need to explain the enigmas of MIDI to a growing and inquisitive audience. Many, including Moog and Jeff Rona, who already wrote columns for popular publications, found themselves in the position of weighting their contributions toward MIDI-related matters. With the blitz of digital instruments on the market, trade publications swelled with product reviews, interviews, and editorials on the state of MIDI within a fast-changing musical ecosystem. These publications shaped popular notions about MIDI in public consciousness, and helped to reinforce its new-normal status in music and computer communities.

In July 1983, Bob Moog published an influential article in *Keyboard* magazine entitled: "MIDI: What it is, What it means to you." Moog compares MIDI data to "a Boy Scout troop marching single file through the woods."[254] The image is apt: it further characterizes the communities of people trying to push MIDI into existence in a wilderness of disconnected instruments and interests. Retail magazine *UpBeat* printed a feature story in their February 1984 issue, titled: "Musical Instrument Interface Has Major Industry Impact." Its author Al DeGenova writes: "In a very short time (about a year) MIDI has established itself as the interface for connecting electronic instruments of different manufacture to each other and most importantly, to computers."[255] Publications like these fostered the cross-pollination of digital communities from a range of musical and informational backgrounds. If DeGenova's emphasis on PC's was initially unclear, he elaborates: "…more than allowing instruments of different manufacture to work integrally with each other, MIDI spells the future of music, c-o-m-p-u-t-e-r."[256]

In May of 1984, tell of MIDI hit *Newsweek*, with an article cleverly called "RAM-a-Lam-a-Ding-Dong." In it, *Keyboard* magazine editor Tom Darter enthusiastically claims: "people will be able to create an entire music learning lab in their homes for not much money."[257] By June, however, disillusion began to show in the MIDI community, a development not lost on its critics. Dominic Milano of *Keyboard* wrote an exposé called "Turmoil in MIDI-Land: The Fast-Growing Synthesizer Industry Struggles to Implement a Standard Digital Interface." Here, Milano stresses the struggle, writing: "[With MIDI] you can hook your synthesizer to a personal computer to do all sorts of wonderful things.... Or can you? Anyone who's tried hooking synthesizers together with it knows that things are not all peaches and cream in the land of MIDI."[258] For all the utopian predictions of MIDI's potential, there were as many articles that confounded popular opinion on the spec, and wrapped it in an air of impenetrable mystique and mystery for the average hobbyist. In Chapter 4, we will see some of the industry and manufacturer reactions to mounting MIDI confusion.

Did Users Matter?

One of its ongoing functions throughout the 1980s was to publish the IMA bulletin, which announced and reviewed new MIDI-capable products, ran editorials assessing the state of MIDI within the electronic instrument and computer industries, and answered letters from institutions, musicians, and other interested parties with MIDI-related problems or suggestions. The bulletin was conceived of as a multidirectional mode of communication amongst users, and between users and manufacturers. There is little evidence, however, as to how much manufacturers were really listening.

In a November 1986 dispatch, American electronic music composer and software developer Laurie Spiegel penned an irate letter to the IMA, reflecting her frustration with the narrowness of MIDI software classifications proposed in the previous issue – classifications that she felt excluded her *Music Mouse* program. Spiegel wrote: "I would suggest the addition of 3 categories to the conceptual landscape into which you organize MIDI software: MIDI Code Stream Manipulation, MIDI Generation, and MIDI Data Analysis (which is a valid category unto itself different from the others for reasons sufficiently obvious not to discuss)."[259] But, having no direct line to manufacturers, the IMA's hands were tied, and they struggled to respond with any substance to these sorts of propositions. Spiegel's suggestions received an abrupt reply, along with a reminder that "an onslaught of new software" would be unveiled at the next NAMM show.[260]

In 1987, the IMA attempted to set up a MIDI referral service for members seeking expertise or employment in music technology, to ostensibly connect professionals looking for work, but really to raise a little extra operating money. In its November bulletin, the IMA solicited members for a three-month registration period at a fee of $15. They then charged a $50 fee for access to the database. But the IMA was already in tough financial straights, evidenced by their continual membership fee increases, and had a difficult time putting such a database together.

Still, the IMA continued to believe in itself, and to editorialize the power of the end user. In a 1989 report entitled "MIDI Malaise," Lachlan Westfall wrote: "it seems that while organizations like the MMA and IMA can always do more to publicize the advent of a new MIDI message, it is ultimately up to each individual manufacturer to include an up-to-date MIDI implementation. And who do the manufacturers ultimately listen to? The consumer!"[261]

The user's contribution to MIDI came in the form of wide-eyed enthusiasm, which translated directly into massive consumption of new musical products. More people bought digital instruments throughout the 1980s as a result of MIDI – so much so that, for three subsequent decades, the instrument industry has been frantically trying to replicate another MIDI-type musical sea change. But its development coincided with a number of other digital technologies – from wristwatches to compact discs and desktop computers. No doubt, MIDI benefited from a broader cultural fascination with digitization, and a capitalist mode of mass-production. But more users who demanded more marginal and esoteric applications for MIDI were quite literally left to their own devices. The open-system concept for designing MIDI was mythologized to an extent, in large part to justify giving it away practically for free. In truth, the model of the MIDI spec's gratis distribution dramatically helped its quick adoption, and would become commonplace in future computer industry practices of "bundling" software and hardware.

The fact that MIDI became the dominant standard for digital musical instruments, however, did not reflect the belief of users to its superiority. Indeed, there was no real marketplace alternative or competition to MIDI, and users were forced to either accept it, or play another tune. Musicians and early adopters did not exert as much pressure on the MIDI spec as did the major manufacturers like Roland and Yamaha, but they did dramatically influence the development of instruments that implemented MIDI afterwards. For example, into the 1990s, keyboard controllers continued to be the most popular input devices for MIDI information, but the development of guitar, string, wind, and percussion controllers trailed closely. And today, an eruption of second-screen MIDI controller applications for devices like iPad and Android is the direct outcome of user-stimulated technological development and proliferation.

MIDI's Industry Impact

Between 1982 and '87, the global music industry's net value climbed from $2.2 to $3.6 billion US.[262] Sales of electronic instruments more than doubled during that time, with synthesizers alone jumping from 43,000 to 378,500 instruments sold annually.[263] Portable keyboards, which were virtually non-existent before MIDI, were shipping nearly 5 million units by 1987. Synthesizer imports to the American market increased 96%, with Japanese models leading the way at a 28% rise.[264] And for the first time, NAMM and the American Music Conference were including music software, a business still in its infancy, on their year-end sales figure lists. In 1987, it was worth $22,000 US, but was poised to skyrocket with the widespread adoption of MIDI and personal computers.[265]

Foreseeing enormous potential, NAMM funded research into how people were using music software, and established five areas of focus: sequencing, composing, recording, sound editing, and storage. The 1988 study notes: "Demographically, software purchasers/users responding to the survey tended to be single males [58%], young (under age 35) [60%], well-educated (college graduates or higher) [58%], and have comfortable incomes, compared to the U.S. median income [51%]."[266] Ease and flexibility of use were among the most important attributes for buyers, but interestingly, brand name was not. To a certain extent, MIDI-compatibility replaced brand recognition, or at least diminished its visibility in a crowded digital products marketplace.

MIDI also contributed significantly to the burgeoning home recording industry. 46% of musicians with home studios first learnt how to play the piano, which justified keyboard instruments continuing on as dominant controllers. Those who bought home recording equipment like outboard signal processors, mixing boards, and reel-to-reel tape recorders were also increasingly consuming MIDI-capable gear in the form of drum machines, samplers, synthesizers, and other sorts of electronic instruments. And more and more, home musicians were starting their musical education with portable keyboards rather than acoustic pianos.[267] With this exponential leap in MIDI-related sales, the job of MIDI-associated groups shifted immediately from brainstorming the future of MIDI to solidifying its present.

With millions upon millions of new MIDI-ready digital devices entering the marketplace, the roles of MIDI-related organizations like the IMA and the MMA changed from innovation to enforcement. The MMA in particular sought to swiftly lock down the specification, and went from an organization that canvassed potential MIDI manufacturers to one that ensured those manufacturers were complying with best implementation practices. By 1987, only four years after MIDI's official unveiling, the MMA's work shifted toward preserving the protocol's integrity, and lending some stability to the rapidly expanding trade in electronic instruments. The IMA continued as a loose information exchange, albeit without Roger Clay or Brian Vincik, and all but abandoned its efforts to officially standardize MIDI under ANSI's aegis. One final push was made in late 1988, when members from the MMA and the AES convened to discuss the possibility of finally etching MIDI into a formalized standard. But once again, the process appeared too long and drawn out for the MMA's liking, and would ultimately involve moving the standard "back five years" by re-opening the consultation process to organizations external to the musical instrument business.[268] Unlike the open dialogue concept envisioned by the IMA, the MMA had always discreetly sought to limit external involvement in the MIDI spec; with all those MIDI-capable instruments out in the field, and myriad more in development, ANSI's was just the kind of outside participation the manufacturing community wanted to avoid most.

Conclusion

When Dave Smith and Ikutaro Kakehashi took home their Technical Grammy Awards in 2013, a great disservice was done to dozens if not hundreds of people whose input and efforts were necessary in bringing MIDI to fruition. Although Smith drove MIDI's early development, it was organizations like NAMM, the IMA, the MMA, and JEMIA that rallied one-time competitors in unison (more or less) around the fledgling specification. Of the core lessons learned from MIDI, paramount is that a technology can be widely adopted without official standardization, and a standard can become standard through other forms of ad hoc consensus making. The success of MIDI speaks to the competency and agency of self-regulating creative communities. While other digital standards, protocols, interfaces, and programming languages came and went (who remembers SCSI?), MIDI endured. It changed, but was never replaced. This was in part due to the speed with which multiple industries converged in its support, and embraced it as fundamental to both software and hardware design. MIDI's cumulative mess trajectory, rather than stimulating the creation of a replacement technology, further embedded the specification into the ecosystem of digital music production.

As standards go, MIDI both followed and deviated from the prescribed path towards widespread acceptance. It was agreed-upon during a period of rapid advancements in all manner of digital technologies, and was done so quickly. MIDI enjoyed an immediately eager audience, and represented them as forward thinking and tech-savvy. In increased sales figures and prestige, peripheral digital industry players like Apple and LucasFilm benefited from adopting MIDI early on while expanding its sphere of influence across broad fields of techno-cultural activity. Under the umbrella of NAMM, synthesizer manufacturers had a ready-made professional network and social forum at their disposal, and NAMM's structure provided the armature for derivative associations like the MMA and IMA. Workshops and conferences operated at once as open forums and mechanisms of closure for the standard to settle and solidify. All this occurred during its first year, which made the process of formalization with a legal standards agency unnecessary, and undesirable furthermore. Had MIDI's designers followed ANSI's path, it is doubtful that the specification would have flourished so quickly, or for so long. The personal responsibility that synthesizer manufacturers took for MIDI meant that their own industries were hedged against its effectiveness. And to a large extent, they won. Electronic instrument sales multiplied in the mid-1980s, and previously unfathomable ways of making music became commonplace. Otherwise disparate agents were brought together as a result of a shared interest in MIDI's possibilities, and new instruments were designed with a higher plateau of user expectations in mind.

Not everyone was satisfied, though. Some believed MIDI should have been faster; others complained that it was serial and not parallel; some refused to accept a 5-pin DIN connector when a more common XLR cable might have sufficed; others lamented the loss of a broad and continuous analogue filter sweep; still, some felt it was all just too technical – making music with MIDI did not resemble playing more traditional pen-and-pencil instruments. But Dave Smith noted from the beginning: "The real bottom line with MIDI is that it is a compromise. It wasn't ever supposed to be 100% compatible with what every machine will do. It can't be."[269]

Chapter 4: Better Living Thru MIDI

> "Here's a little challenge for retailers who have been around for the past couple of decades. Stop for a moment and replay the 1980's in your mind – but leave out the MIDI standard. Scary, isn't it?"[270]

After MIDI was released, it was difficult to determine which developments benefited from which: did MIDI piggyback on the rage for all things digital, or did computers capitalize on technologically adept musicians to grow their industry? The response to both is yes. MIDI was conceived in a time of rapid advancements in all manner of digital technology, and once it was implemented, it became the integral circulatory system of digital information between synthesizers, sequencers, samplers, and PCs. MIDI also emerged in an era when diverse and multifarious new technologies were entering into the marketplace more generally, and Western culture at large was enjoying a fascination with the digital domain. From wristwatches to calculators, Compact Discs to personal computers, MIDI profited immensely from the increasing domestication of these devices during the late 1970s and early '80s. But it will also be illuminating to look at the kinds of industries that flourished as a result of the MIDI standard: *cui bono*? Around this time, a number of advances took place in the world of musical instrument technology – advances that grew out of the interconnectivity afforded by MIDI.

For example, FM synthesis made an entry into affordable, and now MIDI-capable, instruments, having an enormous impact on synthesizer sales, and the industry at large. Cheaper costs for memory and digital storage meant that digital audio production and music software held tremendous imminent potential. Computers could crunch and store greater volumes of data, including high-quality digital audio, and as a result, programs for editing and processing sound files were poised to keep pace in the marketplace with MIDI sequencing software, multiplying the computer-musical business. Indeed, among the biggest benefactors of MIDI's adoption was the computer trade – by the mid-1990s, nearly everyone involved in making music with MIDI was doing so with a PC, and a host of other digital devices, like digital signal processors and digital audio tape. But computers and musical instruments had until then been seen as separate entities, and businesses. Until MIDI came about, making music with computers was largely held to the arcane realm of academia, or in corporate research and development. The convergence of MIDI and the fast rise of a number of computer manufacturers – namely Apple and Atari PCs – would quickly change that. (In the case of Apple, the computer's entry into the music marketplace caused serious problems repeatedly with another similarly named company.) In this chapter, we will investigate what happened to digital music technology concurrently with MIDI's adoption, and examine, via a handful of market research studies and publications commissioned by NAMM, the industry's response to a rapid surge, and ensuing slow slump, in MIDI-related sales.

Survey Says: The Music Retailer MIDI Attitude Survey

Retailers were starting to urge manufacturers to get the MIDI spec – as well as the printed literature about it – written in stone. Musical instrument vendors were bearing the brunt of the MIDI revolution in the 1980s, as scores of new customers suddenly demanded information about the latest MIDI development. Arguably, retailers had never before been put in the position of having to learn about something so technical – so seemingly non-musical – so quickly. The most leading-edge vendors had difficultly keeping up with newer and newer innovations. And to the Mom-and-Pop stores that generally dealt in more traditional instruments, MIDI was, quite literally, another language. In 1988, MIDI-compatibility was the most desired feature for 44% of home recording equipment buyers, ranking a close second behind audio quality. Being easy to understand and easy to use came in fourth, with 27%.[271] Between 1985 and 1987, US imports of Japanese keyboards increased from fewer than a million to nearly two and a half million.[272] But MIDI's growth spurt began to stagnate in the early 1990s. In October 1991, to begin to find out why and what could be done, NAMM commissioned the self-explanatorily titled "Music Retailer MIDI Attitude Survey," prepared and compiled by Stanton California market research firm Loft Marketing for the following January.[273] The survey was designed to canvass potential, current, and non-MIDI retailers to best determine the needs of each category. Ultimately, it was aimed at getting the 75-80% of MIDI instrument retailers proficient with what it called "a fact of life for music retailers," and to figure out what to do about the remaining 20-25% of non-MIDI merchants.[274] The biggest takeaway, though, seemed to be the need to support the average user with training, literature, and simplicity – a position NAMM and the digital musical instrument industry responded to immediately.

The study's authors explain the problem: "At its best, MIDI shows the power of an industry standard, one that allows users to connect a product from one manufacturer into the product of another and (almost always) have it do what you want it to do… At its worst, MIDI is a confusing, intimidating technical bugaboo that … covers an ever increasing range of products, product categories, uses, and techniques that would take a full time job just to keep up with."[275] And while MIDI-capable devices were beginning to represent a significant portion of musical instrument and related sales, music retailers found themselves struggling to keep pace with the advances in technology that MIDI precipitated over the previous nine years. Of several thousand questionnaires, a total of 523 dealers responded to NAMM's Loft retailer survey – a high return that, for a voluntary study with no incentive to participate, attests to the enthusiasm most merchants had toward MIDI.[276] The study was organized to gather information from three groups: those who already sold MIDI products (75%), those who did not (20%), and the small but important fraction of those who did not yet, but had intentions to in the near future (5%).

Those who did not carry MIDI related gear tended to specialize in non-digital instruments, and were generally uninterested in getting into the MIDI game at such a relatively late time. Many felt that MIDI instruments would interfere with the image of their more traditional stores.[277] But some believed that by updating their inventory and expertise to include small sections of MIDI-capable instruments, they could potentially attract a new and lucrative kind of customer. Regional markets were shifting too, and more people were starting to buy digital musical equipment outside of major urban centers. Most potential MIDI merchants just wanted some simple sales training, a straightforward guide, and sought to sell low cost, entry level equipment like portable synthesizers, drum machines, and cheap digital keyboards.[278] Due to MIDI's breakneck infiltration throughout the 1980s of everything from church organs to jukeboxes, by far the largest group was those who already did sell MIDI instruments and devices – those who were looking for some assistance managing the transition into the digital music marketplace. This last group, the top 75%, mainly sold instruments to amateur keyboard players, students, home studio operators, and an emerging class of "prosumers" – aspiring hobbyists or semi-professional musicians. It is interesting to note that, of those who sold to professional musicians, many pegged them in the comment section as being "the least profitable type of customer."[279] While manufacturers focused heavily on the demands of professional musicians, nearly half of the survey's dealer participants claimed they made up for less than 5% of their business. "These efforts do not seem to make sense," claimed the study's authors, "in light of the volume of sales from these professionals."[280] The only less profitable group for MIDI sellers was wind and horn players. Synthesizer hobbyists, home studio owners, music students, and semi-pro keyboard players, however, encompassed the bulk of buyers for digitally interfaced instruments: amateurs, the survey said, were "the bread and butter for MIDI dealers."[281] A staggering two-thirds reported that churches made up between 10 and 30% of their markets. One

Figure 18: The Akai EWI1000 "Electronic Wind Instrument" MIDI controller at the NAMM show, Chicago 1987. Trond Bratten Archives.

forward-thinking dealer in particular proposed MIDI as a strategy to entice younger church organists into an otherwise fairly unhip profession.[282]

Gone were the days of Herbie Hancock spending $25,000 on a Fairlight system – musicians of his caliber rarely walked into retail environments, more often receiving instruments for free straight from manufacturers, in development, product-placement, or endorsement deals. These kinds of cozy relationships were less common in the 1970s, when instruments were comparatively scarcer, and more expensive. Bob Moog reportedly made Hancock pay for his Minimoogs, saying, "Well, the Beatles paid for theirs, and Pink Floyd paid for theirs too."[283] When they did buy, professionals were more likely to stack their studios with top-of-the-line gear, which required less frequent updating. While the Hancocks, Emersons, and Wakemans of the world were stimulating development in MIDI technology, the average prosumer was proverbially putting food on the retailers' table. It was the emerging class of prosumer that required the greatest attention.

Dismantling the MIDI Tower of Babel

The support material that MIDI retailers requested was, as expected, aimed at the lowest common denominator, entry-level buyers, and also singled out brochures for the education and church markets. Dealers also suggested videos that could be loaned out to customers, "to take the mystery and intimidation out of MIDI equipment."[284] Retailers called for sales and training seminars that would travel from store to store, rather than dealers traveling once a year to conventions like the AES and NAMM. Most of all though, the rhetoric that both dealers and NAMM wanted to see in these training materials was the continued promotion of the overall agenda to create more active music makers, more broadly. They believed it should explicitly communicate how beneficial MIDI could be to the practice of making music, and how MIDI-related musical instruments could "unleash the creativity in you."[285]

Dealers had a mouthful of advice for manufacturers as well. Of those who were planning on soon getting into the MIDI market, support for small dealerships through standardized starter programs ranked high on their list of suggestions. Because amateurs were the largest consumers of MIDI products, dealers hoped to see more support for them, and less emphasis on the narrow margins made from professional musicians. They suggested better product manuals, and new information on products *before* they hit the shelves. Salespeople required routine training, which retailers felt should be at least in part the manufacturers' responsibility. And even more than wanting to see the standardization of the MIDI spec, merchants were concerned with the expanding lexicon of impenetrable terminology that often confused average salespeople, and turned potential customers away from buying MIDI equipment. Hooking up the gear and making it perform simple functions was one thing, but communicating how to do that to an inexperienced musician required standard terminology, with straightforward explanations. Encouraging a common lexicon around MIDI, retailers urged manufacturers to "dismantle the MIDI Tower of Babel."[286] To dealers, a standard digital interface protocol was useless in the absence of a standard language for talking about it.

Rapid obsolescence was also a major concern. Although MIDI itself was not changing, manufacturers were still implementing it in different ways, which made some devices irrelevant barely after opening the box. Non-MIDI retailers longed for more consistent and durable kinds of product knowledge, and retreated into selling the instruments they knew best. 20% of retailers were in the non-MIDI category, in general dealing in guitars, stringed or band instruments, educational publications, and sheet music. Tellingly, the drop was off for specialty percussion stores, which the survey's authors attribute in part to MIDI-capable drum machines and digital samplers.[287] And a large portion of piano and organ dealers had dedicated at least part of their retail environments to MIDI, since keyboard instruments were by far the most popular MIDI controllers. Some reluctantly carried MIDI-capable instruments strictly because that was the way they were manufactured, but showed no real attempts to use it as a selling feature. One dealer commented: "'I am of the opinion that pianos are the most profitable items in my market and consequently do not want to tie up floor space with less profitable items."[288]

Why Not MIDI?

The study was not designed to force stores into selling MIDI gear. But the main question the industry at large had for those who did not was: *why not*? Generally, the reason a store refused to stock and sell digital and MIDI-capable instruments was because it was simply outside of their scope. Customers who wanted banjos and mandolins, for instance, viewed MIDI as an unnecessary complication. Smaller and more traditional musical instrument retailers found that there was just no demand from their smaller and more traditional clientele. Many who had been in the instrument retail business for awhile felt like old dogs: they were not knowledgeable or confident enough to sell digital gear, and it was probably too late to learn in order to compete with established and specialized MIDI experts. Still, some retailers had all-out contempt for anything with a cord, and a solid base of customers who felt the same.[289] Select retailers complained that their relationships with manufacturers were hostile, and more about sales figures than customer satisfaction. This may have likely been a result of two key causes: many manufacturers, especially the Americans, were in real dire financial straits due to increasing competition and other various factors; and the onslaught of new players in the market, who had not yet developed long-standing relationships with their clients. Another telling comment recounted in the survey reveals block booking-like strategies on the part of manufacturers: "One guitar shop noted that they would be interested in carrying MIDI guitars. But most manufacturers won't sell to them unless they also carry synthesizers. As they are not a full service store, they do not wish to take on other MIDI products."[290] Synthesizer manufacturers entertained hopes that MIDI might help them infiltrate and bridge previously segmented instrument markets. But there was a breed of purist, who crossed musical genres – from Folk to Heavy Metal – who would not buy into MIDI under any circumstance. Besides, mass-produced synths were worth less to stores than a custom-made Gibson guitar.

Indeed, the comments that many of the retailers anonymously included in the survey are most revealing of the brewing "turmoil in MIDI-land." Some stores started out selling MIDI-related gear, only to realize that, because the cost of synthesizers and other kinds of digital instruments was on the decline, so were their profit margins. One commentator wrote:

> Sold synths in our store from 1985-90. We had a good semi-pro market, until that dried up in 1989. We started promoting to the amateur, who felt MIDI products were not user-friendly. We spent many hours with these customers, often many hours with the same customer. The profit margins did not justify the time spent to sell confusing MIDI product to the average consumer. We closed our Keyboard Department in January, 1991.[291]

Traditional instruments like guitars and pianos might not have sold as regularly, but they were more profitable when they did. Furthermore, many dealers blamed the MIDI manufacturers for poor retailer support. Guitars may have required periodic maintenance, but they never necessitated tech support like digital instruments. For some stores, eschewing MIDI meant continuing to make a tidy profit from traditional instrument retail, and slinging axes (not to mention guitar strings) without the headache or cut-throat competition of keeping up with every new development in technology.

Only 28 of the over 500 surveyed were intending to get into selling MIDI-capable gear in the future – not necessarily a statistically significant percentage, but interesting nonetheless to NAMM. The most willing participants to be newly recruited were general musical instrument retail outlets, and percussion shops wanting to cash in on the popularity of electronic drums (which, in skeuomorphic fashion, you still needed to be a "drummer" to play), and MIDI-compatible drum machines that might reel non-percussionists through the door. The kinds of instruments these dealers hoped to add – MIDI accessories, synths both cheap and high-end, sequencers, samplers, and music software – generally reflected the concurrent landscape of MIDI-related sales. Only four intrepid souls reported that they planned on selling computers. Of the reasons cited for wanting to carry MIDI products, the highest portion of the group felt that there was now a sufficient demand to be filled in their local markets. Several believed that it would attract new customers to their stores. Those new customers would be culled from the amateur and hobbyist communities – the most loyal and profitable kind. Still, the survey's authors noted that stocking MIDI equipment would be the easy part; educating staff and a potential buying public might prove far more challenging.[292]

Not in the Manual: Taking The Mystery Out Of MIDI

An overwhelming 390 responded that they currently sold MIDI gear, although not always gladly. It is significant to point out that, for the first time since MIDI's release, synthesizers had taken second place among the store's current product offerings – although this number is likely due to the fact that many digital synthesizers started coming coupled with built-in sequencing equipment or software. Keyboards, both home and portable varieties, still occupied second and third rank. Most retailers did not sell computers themselves, although some reported alliances with a local computer retailer. Almost all responded that they wished the computer and musical instrument industry would work together more closely.[293]

18% of music retailers also sold computers and computer equipment, such as sound cards and outboard gear, and were interested in training programs for their staff. But mainly, MIDI instrument merchants also wanted some simple explanatory material aimed at the home hobbyist – their most lucrative customers. The top demanded support for retailers was some kind of small brochure that they could hand out to novices and other prospective customers, explaining the ins and outs of MIDI, in basic pedestrian language that anyone could understand – both dealers and buyers.[294] Retailers were also increasingly requesting instructional videos, perhaps foreshadowing the enormous popularity of online how-to videos a decade later.[295] Although they were supposed to guide users through their new devices, manuals were most often written in undecipherable language. One vocal dealer chided: "You don't dare show the customer the manual if they're confused."[296]

If dealers believed the avalanche of new MIDI-related products increasingly puzzled their everyday customers and turned them away from purchasing because of digital interfacing's perceived complexity, NAMM sought to ease retailers' woes by giving them exactly what they asked for: a new brochure. Howard Massey's *Taking The Mystery Out Of MIDI* was published in 1992 by NAMM, and endorsed by both the IMA and MMA organizations. The guide was filled with illustrations and explanations in common vernacular geared toward amateurs – what retailers believed to be the biggest untapped market. However, selling the ease of MIDI was a difficult proposition considering widespread opinion to the contrary. In short, NAMM was writing a brochure not because buyers already believed using MIDI was easy. Rather than describe MIDI as a protocol or a specification as other technical literature did, Massey characterized MIDI as a "computer language 'spoken' by virtually every electronic musical instrument manufactured since the early 1980s."[297] The rhetoric of "language" went a long way toward naturalizing MIDI in the minds of potentially reluctant beginner buyers, and also helped MIDI sound familiar to computer users who may have been interested in getting into making electronic music. From the outset, Massey established personal computers, including IBM, Macintosh, Apple, Atari, and Commodore Amiga as "MIDI devices."[298]

Figure 19: Graphic from "Taking the Mystery out of MIDI," NAMM 1992.

Massey's language metaphor for MIDI is compelling. He notes that, like written language, MIDI code has a system of letters, words, and sentences, a specific structure, and syntactic rules that must be followed. In order to understand a language, it must be universally decoded, however. And despite all the talk of its universality, MIDI still had a reputation for common incompatibilities between manufacturers. Recall that dealers had complained about cascading inconsistencies in the application of the MIDI spec, and the rapid obsolescence of MIDI equipment.

Massey moved to quash these perceptions forthwith by reiterating the mantra of MIDI's manufacturer-independent interoperability: "one of the real strengths of buying a MIDI instrument is that it can never become obsolete," he writes.[299] "The MIDI Specification is periodically updated as new features are added—but the basic rules governing MIDI always stay the same."[300] Of course, this was not entirely true.

NAMM's brochure often came off like a hokey script for an institutional film, designed to simplify the public's perception of MIDI, but also to gloss over the negotiations and struggles that brought it about in the first place. In his account of MIDI's development, Massey invokes the rhetoric of digital superiority, likening microchips to CDs, which "use digital processes to produce much higher-quality sound than vinyl records."[301] He explains sequencers as "tapeless recorders" that store not musical information itself, but information about musical performance. Sequencers are the playback machines for synthesizers and other electronic instruments, just as disc drives are playback devices for digitally encoded musical data, according to Massey.

The missing link here, obviously, is MIDI: the "pathway through which the synthesizer can 'speak' to the sequencer for recording and another pathway through which the sequencer can 'speak' to the synthesizer for playback."[302] He tellingly notes that individual manufacturers initially conceived of proprietary interfaces to get their own instruments to "speak" to one another, but credits the manufacturing community and industry leadership for the heroic spread of MIDI as a global language. "In a universal spirit of cooperation rarely seen in any industry," Massey continued, "most manufacturers joined forces to make this idea a reality."[303] MIDI is portrayed here as an inevitable development – a language that evolved rather than a specification created by and for a few very interested parties. But, despite its discursive history, Massey heralded MIDI's implicit democratizing force, unifying not just sequencers and synthesizers but an entire constellation of guitar, drum, and wind controllers, mixing boards, remote machine control, musical transcription, lighting equipment, and the like.

Jive Talk or Jargon?

Massey tiptoed toward the terminology of MIDI by comparing MIDI messages to words, which travel down one or more of 16 channels, similar to a broadcast television channel. MIDI was as easy as flipping through TV stations, according to the brochure. Like television lines, MIDI cables carry information from 16 discrete channels through a single wire. Of course, the trick here was to create analogies to well-established communication forms, regardless of whether the comparisons stood up or not. Massey approached the nomenclature around MIDI receive modes. (We might recall that the misinterpretation of 'Mono' mode initially caused Yamaha engineers some problems in their MIDI implementation; and 'Poly' mode that replaced it, meaning that a device will only receive on a single channel, seemed similarly counter-intuitively named.) Nonetheless, Massey stuck with the broadcast television metaphor until it broke down in his explanation of 'Omni' mode, whereby a device receives on all channels simultaneously – "there's no earthly reason why you'd ever want to do this on your TV set," he concedes.[304] 'Multi' mode, which is intended to receive multi-timbral information across a series of channels, Massey likened to a picture-in-picture television, before having to explain in a footnote that 'Multi' was not an official MIDI mode described in the specification, although many manufacturers had adopted it. Already, the brochure's intended strategy for simplicity seemed to be missing its mark.

Massey continued to explain the most common channel messages: Note On (which actually contained both note and velocity information), Note Off (which in some instances was simply a Note On message with a value of 0), Control Change (which was integral to the "expressivity" of real-time controllers, emulating modulatory characteristics of acoustic instruments, such as vibrato), Pitch Bend (which as we know was never standardly implemented), After Touch (likewise), Program Change (which allowed the switching of preset or stored sound patches), Local Control (which turned a synthesizer's own voices on or off, essentially turning the instrument into a pure controller), Reset All Controllers (a kind of panic button), and All Notes Off (another, more urgent kind of panic button).[305] Likewise, Massey summarized system messages such as Sequencer Start Stop and Continue, Song Select, MIDI Clock (measured in pulses per quarter note), Song Position Pointer, MIDI Time Code, System Exclusive (or SysEx), and Sample Dump Standard, before mentioning: "just as not everyone who speaks English uses the entire English vocabulary, not every MIDI device transmits or responds to all MIDI messages." Ultimately, Massey suggested: "To find out precisely which words are in your instrument's MIDI 'vocabulary,' refer to the MIDI Implementation Chart provided in most owner manuals" – precisely the publications that both users and dealers often found more frustrating than illustrative.[306]

Easy Does It: General MIDI

The intention of producing publications like Massey's was to overturn the general assumption that MIDI was some arcane and esoteric technical specification that only the most advanced practitioners could master. But in contrast to other easy-to-use devices that came before it – leisure instruments like Dad's Pianola, which required little to no musical or technical skill – MIDI was often not at all relaxing. So, the benefits of using MIDI had to be laid on thick: simply layering one sound over another, or transposing sounds from one keyboard to another, was described as nearly miraculous.[307] Sequencers were touted as: "much more powerful than tape recorders … they allow you to do 'micro-surgery' on individual events so that mistakes can be corrected, individual notes moved forward or backward in time, passages transposed, tempos adjusted, etc."[308] Like computer disks, Patch Librarians could store the contents of entire machines (but unlike standardized floppy diskettes, different devices often used different kinds of storage media – another cascading problem of standardization). MIDI could transcribe entire performances into musical score notation: "And your performance doesn't have to be perfect," said Massey; "any mistakes you make can easily be corrected on the computer screen prior to printout."[309] Making music with MIDI sounded easier than ever, but the fact was that a rift was developing between the kinds of musicians to whom MIDI came naturally, and those who would be reassured by no manner of supercilious brochure.

Sales of keyboard equipment of all kinds started to taper off in the early '90s. At roughly the same time that NAMM was compiling the results of its retailer attitude survey, and to a certain extent foreseeing the outcome, the MMA and JMSC were scrambling to put together something for the low-to-no-skill market – both musical and technological. Those who were not intuitively proficient with new kinds of devices required another even more simplified kind of MIDI. Users were becoming accustomed to being able to "plug and play" with other kinds of consumer electronics such as home entertainment and gaming systems, and computer hardware. And a certain and very profitable segment of the market simply had no interest in reading manuals; if it did not function immediately as they expected it to, they did not want it. Predominantly focusing throughout the late 1980s on the demands of pro and semi-pro keyboardists, major synthesizer manufacturers raced to create all-in-one workstations, the more features the better. (Korg's M1, 01/W and Wavestation line, and Kurzwiel's K2000 were notable examples.) But those who bought expensive synths such as these did not do so year after year.

At the 1992 NAMM show, there were few such monster keyboards: the biggest announcement, rather, being General MIDI – not just a streamlined set of MIDI rules, but an all-new class of instruments. General MIDI instruments would all have multitimbral capabilities, their memory structures would resemble one another, and they would be automatically set to send and receive different types of instruments on standardized channels. They were the answer to the still-mystified segment of the marketplace that had yet to buy in. "If you're just getting into MIDI," wrote Massey, "you'll probably find these instruments to be the ideal 'starters.' Most importantly, because they speak the universal language of MIDI, they can be integrated with any other MIDI devices as you build your system in the future."[310]

However, writing for *Computer Music Journal*, Joseph Rothstein had a slightly different take: "It may be only coincidence that General MIDI was adopted during a profound industry slump, but it appears that vendors are pinning their hopes on this new extension to the MIDI specification to revive the industry's flagging sales. General MIDI was designed with the novice, non-technical MIDI user in mind, and its adoption could not have come at a better time for the industry."[311] MIDI might have been adopted in haste, during an upswing for the synthesizer business, but General MIDI came just as fast to stabilize it during a downturn. Still, more than the novice and non-technical, MIDI manufacturers turned their attention to the mounting army of computer users next.

Evan Brooks and Digidesign

Figure 20: The Digidesign booth, NAMM show 1987, Chicago. Trond Bratten Archives

In 1983, Evan Brooks and Peter Gotcher were two pals in a California rock band, looking for a way to expand the E-mu Drumulator (a sample-based drum machine) Gotcher had just purchased. He was tired and unhappy with the limited range of drum sounds that came standard with the device. Brooks had a College degree in electrical engineering and computer sciences, so Gotcher asked him if he could figure out a way to make a new set of sounds. After a fairly short time, and with the full assistance of Scott Wedge, Dave Rossum, and Marco Alpert at E-mu, that is exactly what Brooks did.

Roger Linn had made the similar LinnDrum in 1982, but at several thousand dollars, it was inaccessible to the average musician. One of the reasons for its expense was the cost of digital memory, which stored the audio data as Read-Only Memory. Linn's machine used one chip per sound. E-mu, however, compressed their samples onto a single chip. This made it easy for Brooks and Gotcher to produce batch sets and simple libraries of sounds. So, the pair purchased an Emulator sampler, and E-mu wrote them some custom software to be able to take the digital audio data out of the sampler and into a computer, edit and process the sounds digitally, and then dump them back into the Drumulator. They came out with three sets of drum sound chips, and started selling them back to E-mu – their most willing first customers – under the name Digidrums.[312] On April Fools Day 1984, anticipating that their innovations would go well past drum machines, Brooks and Gotcher incorporated Digidesign.

According to Brooks, E-mu was a company on the bleeding edge of digital technological development. They were not only making innovative machines, but also doing so at a price that more people could afford. Soon, Oberheim, Sequential Circuits, and Yamaha were developing their own digital drum machines, and each company contracted Digidesign to produce sample libraries for them. Digidesign's process was purely digital: they would begin by recording real drum sounds onto a Sony PCM-F1 16-bit digital recorder. Dana Massey, an engineer with E-mu, figured out a way to hack into the Sony, and transfer the digital recordings into the S-100 bus hobbyist computers they had specially designed for the task. But their computers were slow, which meant non-real-time operations, and signal processing in ASCII.

In 1984, E-mu released the Emulator II, with a higher sample rate and more real-time control through analogue filters and modulation. The same year, Apple released their first Macintosh, which gave Digidesign the opportunity to build a graphical user interface for sample editing. Even basic sampling requires some advanced abilities, like clipping off the pre-roll to produce immediate attack, fading out the sound, truncating, and finding the points at which the waveform crosses the zero axis to create seamless loops, for example. The Mac's display made viewing and editing samples far simpler than estimating in ASCII. Graphical user interfaces were a big deal, and radically different from previous text-based command line interfaces. The product that Digidesign ended up releasing was called Sound Designer, a fully-fledged graphical sample editor for the Emulator II and Macintosh computer. And although the whole package – sampler, computer, software, &c. – would run well into the tens of thousands of dollars, they were still considered cheap against comparable Synclavier and Fairlight systems. Despite short-lived competitors like

Turtle Beach's SampleVision software for the Korg DSS-1, when other companies started making more affordable samplers, Digidesign was the go-to team to create customized versions of Sound Designer for each individual manufacturer. And so, interfacing with Sound Designer became the de facto first consideration in the product development phase for most subsequent digital sampling devices.

Digidesign took full advantage of the technologies they had available to them at the time, and also had faith that innovation would quickly make those technologies better and cheaper. In 1989, working closely with Terry Shultz (formerly of E-mu, then at Motorola) and Apple's advanced technology research and development group, Digidesign added one of Motorola's digital signal processing chips to a new bus card, which allowed for 2 channel, 16 bit stereo audio recording, with dedicated real-time signal processing. Calling their new product Sound Tools, Brooks and Gotcher took it to the 1989 NAMM show, as an inauspicious technological demonstration. Promoting Sound Tools also meant selling the idea of digital recording – something that the concept of MIDI had already gone up against. In Digidesign's initial literature for Sound Tools, they described it as "the first tapeless recording studio," reiterating a common line from MIDI rhetoric, and arguably more legitimately.[313]

In 1991, after renaming its hardware and software bundle ProTools, and redesigning it graphically away from sample editing and toward a functioning virtual post-production studio, MIDI had some real competition in Digidesign. MIDI's tapeless studio concept looked nothing like ProTools: MIDI recorded information about sound into the digital domain; Digidesign recorded *sound itself*.

And the number of audio tracks that ProTools could manage in real time was only dependent upon the processing and memory speed of computers, which were getting exponentially faster and cheaper. MIDI instrument manufacturers knew that competing with the oncoming tidal wave of computer use was impossible; so, instead of trying, MIDI joined the computer craze at every turn.

By the Numbers: Making Music With The Computer

Figure 21: Sign of the times: NAMM show, Chicago 1987. Trond Bratten Archives.

In 1995, NAMM commissioned a survey of computer owners – both Mac and Windows machines – to determine the demographic profiles and buying habits of computer-equipped musicians, as well as the potential tendencies of non-musical personal computer users.[314] The research base was composed of 402 subjects, half of whom had purchased some sort of computer music software, hardware, or other type of accessory during the previous year. The other half was comprised of everyday home computer buyers who did not make music, in order to identify and better target prospective markets for digital musical instruments and equipment. The prestigious opinion polling organization Louis Harris and Associates of New York City conducted and compiled the detailed and exhaustive 467-page study, with customer information provided by NAMM-cooperative instrument, hardware, and music software retailers.[315]

The survey found that the statistically representative computer musician was a young white male with a "moderate income and a slightly higher level of education than the typical computer user."[316] Those who made music with a computer did so mostly with electronic keyboards, pianos, and guitars, and employed at least seven pieces of hardware or software in their studios. The three most popular tools for making computer music were MIDI interfaces, sequencing software, and synthesizers. Among male users, most purchased their computer music equipment based on product reviews in music magazines and trade papers, while word-of-mouth was preferred amongst women. All buyers' primary concerns were with the capabilities of the equipment they purchased; the study notes price generally as "a distant second consideration."[317]

Most musicians tended to stick with buying their digital music equipment – both software and hardware – in a music store rather than from a computer source, which many found to employ staff with insufficient musical knowledge.[318] However, the small group of potential non-musical computer users – those who were not musicians, but might consider purchasing computer musical equipment sometime in the future – was more apt to go to the computer store for further information on musical equipment. This meant that computer vendors had to be conversant in music technology, and vice versa. Digital music-makers composed a lucrative market: they averaged three computers to non-musicians' two. Like computer musicians, everyday computer users tended to be young and affluent, and more concerned with the features of their chosen products than the price.[319] Digital musicians favored Macintoshes while non-musicians preferred IBM PCs and clones, and computer musicians were more likely to add multimedia devices like CD-ROMs and writers into their setups.[320]

The most startling difference between computer musicians and non-musicians, however, was gender: 94% of electronic music makers were men, but they composed less than a third of non-musical computer users – a difference that even the polling organization ventured to guess was "presumably more gender-divided than general music-making done without a computer."[321] Based on responses across a variety of questions, both musicians and non-musicians were indexed as low, medium, or high for their computer music experience. The survey found that "only one in twenty women are in the medium and high experience categories."[322] Remarkably, women who did make music with MIDI were interested in its extra-claviocentric capabilities, and often pushed the technology in surprising ways. British composer Kaffe Matthews used a MIDI violin controller during her studies at York University, and San Francisco-based sound artist Pamela Z performs with a wearable controller called BodySynth, which renders her movements into MIDI messages that produce music.[323]

Of the top three instruments used by computer musicians, 45% had synthesizers and other electronic keyboard instruments, with as many (44%) reporting knowledge of the piano, and guitar coming third at 37%.[324] Obviously, some respondents reported knowledge of several different kinds of musical instruments; interestingly, 6% of computer musicians also reported playing trumpet.[325] But claviocentrism was alive and well in this study, with almost half of computer musicians educated in music on keyboard instruments. Moreover, digital synths were used by 56% of computer music makers – 52% of whom were considered professional musicians.[326] A little more than half of computer musicians claimed to make a living making music, with 45% confessing to be amateurs. However, just 23% of non-computer using musicians made music professionally, so computers were increasingly becoming conceived of as tools for the serious musician.[327] This represented precisely the prosumer market that NAMM was hoping to tap into: the interstitial, aspirational, computer musician.

MIDI-centrism

Of the survey's participants who used computers to make music, it is telling to see the kinds of equipment they were using in 1995. NAMM's goal for canvassing musicians was to determine what gear they were acquiring, whether they were using their new gear or cherishing older instruments, and what they planned to buy next.[328] From musicians' responses, a list of thirteen basic computer music devices was compiled, of which a majority used eight; in descending order of popularity, they were: a MIDI interface; an analogue tape recorder; a mixing board; effects devices; a rack-mount sound module; a keyboard sequencer; digital audio recording and playback equipment (samplers); a drum machine; an add-on sound card like "Sound Blaster;" a built-in sound card; video recording and playback equipment; a sequencer module; and a digital multi-track tape recorder.[329] Note the marked absence of what, only 7 years prior, looked like staples of the music products industry – "pen and pencil" instruments. Indeed, only a little over one quarter of computer musicians reported using acoustic drums, guitars, wind, and brass instruments.[330] The data reflect that the American Federation of Music might have had a valid point against music technology when they blacklisted Don Lewis: MIDI apparently became a substitute for other kinds of musical practice, and an extension of the one-man-band, all-in-one, no-experience-required rhetoric of music technology development. And because MIDI was such a claviocentric technology, this extended that universalism still further.

From the results of the survey, it was clear that MIDI was integral to the computer music production environment; by far the most popular of the thirteen devices, 92% of users owned a MIDI interface. But they were not the most popular year-over-year purchases; once they were integrated into the studio, they rarely needed replacing. Instead, devices like rack mounted synths and sound modules, and sound cards – both built-in and aftermarket – were gaining traction in the computer music marketplace. And the most desired devices to be purchased in the future were things like outboard effects processors, and digital audio recording gear.[331] Nonetheless, MIDI had achieved synonymy with computer compatibility for musical instruments.

The study singled out three other popular device categories: MIDI-compatible keyboards, non-keyboard MIDI instruments, and MIDI computer software. 91% of computer musicians used some form of computer-compatible keyboard, and 87% used a synth.[332] Portable keyboards were the second-most popular devices at 63%. And digital musicians were increasingly purchasing digital samplers (52%), digital synthesizers (47%), and digital pianos (44%) – and were planning to purchase more of the same in the near future.[333] Non-keyboard instruments were used by only 34% of computer musicians, with 40% of those using MIDI triggered drums, and 27% using guitar controllers. And it seemed as though musicians were becoming less and less interested in acquiring non-claviocentric instruments in the future, with only 13% (of the 34%) saying they intended on buying a guitar in the coming year.[334]

91% of music makers used MIDI software with their computer setups.[335] 93% of those used sequencing software; 61% worked with MIDI notational software; and just under half (49%) used some sort of editing or sound library software. Multimedia software was both the most recently purchased type (77%), as well as the most intended to be purchased (40%). Educational (70%) and sequencing software (63%) rounded out the list of popular programs desired most frequently by computer musicians. Soon, almost all digital music would have a software component, with plug-ins and shareware proliferating peripherally. Along with the three other most popular categories for computer music products, software moreover possessed important potential for breaking into the all-important wealthy/white/educated non-musician computer markets, which NAMM and the industry at large were paying such close attention to through studies like this. Still, the manufacturers were beholden to their most loyal customers: two thirds had been at making computer music for over a year, and generally had a lot of time and money invested into their craft.[336] Digital multi-track recording devices had the most to gain, still unused by three quarters of computer musicians. And adding processing into the signal chain through outboard devices like effects and sound modules was a phenomenon being watched closely by manufacturers like Roland (who made the popular Boss guitar pedals) and Yamaha (makers of high-end all-in-one effects racks like their FX and SPX series). And although a healthy seven percent of computer musicians resisted using MIDI altogether, MIDI keyboards, synths, samplers, and other claviocentric forms of control were hard-wired into the architecture. Even though more manufacturers were spending resources developing non-claviocentric devices (like Akai's EWI series, for instance), they occupied a nearly negligible margin of the marketplace (MIDI saxophones were the least used digital device, at a paltry 3%), and showed little signs of improvement.[337]

Figure 22: Gone with the Wind: The Ill-fated (and now highly collectible) Artisyn MIDIsax controller, NAMM Chicago 1987, Trond Bratten Archives.

Taking Aim at the Market

The kinds of concerns that potential purchasers had were, of course, of particular interest to the survey. Of utmost importance were where people generally got their information, the kinds of considerations that went into buying or not buying, and the methods by which they evaluated products.[338] It seemed most buyers preferred to inform themselves before walking into the retail environment, but once they did, they were more likely to lay substantial amounts of money down for the products and software that most suited their expectations. Two thirds of musicians relied upon musical instrument and industry-related magazines and related publications. Word of mouth and dedicated seminars were considered equally useful to computer musicians, although word of mouth came in a distant second to the trades. Fewer still relied solely on store visits, perhaps fearing predatory sales tactics at the hint of music technology ignorance. MIDI also came of age alongside new kinds of music technology journalism, which smoothed the way to prosumer expertise.[339]

Perhaps unsurprisingly, the most important aspect of musicians' decision-making process was the set of features of a given product, identified by 68% of respondents.[340] Price came in at a distant second, with merely 31% claiming to be most influenced by cost. After they purchased the product, 80% of users wanted information to continue to be made available, and 76% cited the desire for product and technical support.[341] The authors of the study point out too that an overwhelming 78% of computer musicians reported to be more tech-savvy and experienced with new forms of media and communication, and were prepared to embrace burgeoning online user communities and databases – both for purchasing and maintenance (i.e. version updates, bug fixes).[342] The study further indexed computer musicians into "high" and "low" chances of buying equipment, noting: "Those future cyberspace songwriters who have a 'good' chance of buying equipment are more interested in an online network for purchasing than those whose chance of buying equipment is at best slim."[343] Here, we see the parallel development of networks: MIDI, and the Internet. The user groups' online forums that are so important today furthermore represent a wide variety of music instrument design and marketing.

Even though they were conversant in computer lingo, and well acquainted with a variety of new digital technologies, computer musicians were still buying their software from music stores and catalogues (59%) over computer retailers (33%).[344] Furthermore, music product sources were vastly preferred by the young and less educated, with 67% of high-school educated buyers getting their software at traditional music retailers, compared with just over half of college grads. Conversely, the older and better educated among computer musicians skewed more towards computer retail outlets, with catalogues ranking highest among those over 60. Online retail sales were beginning to see significant margins (26%), but only when participants were prompted to think of other potential locations.[345] Still, it is interesting to note that although convenience is an often-cited factor in the rise to online software sales more broadly, again, it did not occur to unprompted participants. Today, however, online software purchases constitute the bulk of sales.

A similar story emerged with computer music hardware, with most musicians still preferring to shop in the music retail environment. 49% of those searched out stores with a specialization in computer music, and only 24% went for computer retail or catalogue buying.[346] Most respondents found the general expertise of music store employees exceeded the knowledge levels of those working at computer outlets.[347] It was clear that NAMM was doing its job educating retailers on new digital and MIDI-related products – 58% rated their last salesperson's expertise as "excellent" – but computer retailers were not catching on, likely due to the onslaught of new kinds of hardware and software for all sorts of applications, from something designed to do personal income taxes or word processing, to complex and dedicated gear for making music, movies, and other forms of multimedia. A staggering 14% of computer musicians said they had *never* purchased a product from a computer retailer.[348] For the majority of computer retailers, MIDI still did not quite compute.

The Next Generation

One key aspect of the survey was to identify the potential of people who used computers, but not necessarily for making music. Some computer users were found to be quite aware of, and, on paper, very interested in making music. 28% responded that they were "somewhat" or "a great deal" interested in making music with their computing machines. Most, again, tended to be male, Midwestern, well off, and single; 55% of females claimed no interest at all in making computer music. The gender gap between those interested in becoming computer musicians was found to be even greater than that between overall computer users throughout the study. Men were twice as likely to want to become musicians with their computers than their female non-musician counterparts.[349] Time and time again, men were overwhelmingly the target market for both existing and burgeoning computer music instrument trades.

With equal caution and enthusiasm, the study pointed to a small but dedicated set of the base – about 30 computer users who were not yet musicians, but were interested in making music "a great deal."[350] This segment of the study was designed to understand the music instrument industry's real target market: those computer users with musical ambitions, and a bit of disposable income. The group responded that there was a good or better chance that they would purchase computer music-making equipment in the next year. But the majority of them only had either vague notions or no idea at all about music software. And while industry magazines were a preferred source of information for these potential musicians, the music store would be the field to win crucial new recruits. Similar to veteran computer musicians, this group cited features over price as the most important factor for purchasing software, and 70% of them affirmed their interest in online product support networks.[351]

The emerging generation of computer musicians in the study used a lot more digital equipment than non-musicians, on the whole, and was becoming more discerning in the types and brands of their technological gear. By slim but significant margins, computer musicians preferred Macintosh computers to IBMs and clones, with 43% of professional musicians regularly using Macs for their craft.[352] But IBMs still dominated both the musical and business machine marketplace, garnering around two thirds of all users. Predictably, the musicians tended to have newer and more powerful machines, with more RAM memory, and running more advanced multimedia-type programmes.[353] Aggregating groups of responses to the questionnaire created three important indices: the "Music Software Experience;" "Chance Will Buy;" and "Amount of Music Equipment" categories. For example, musicians with seven or more devices were placed in the "high" amount of music equipment set.[354] Younger users and professionals tended to be most savvy with the latest peripheral devices, with half of those under 30, and 62% of professionals, claiming ownership of a CD-ROM drive. And 41% of respondents said that they intended on buying a CD-ROM in the coming year.[355] It was crucial to market to the youngest buyers, too, who were potentially the most enduring, and quickest to adopt the latest innovations, regardless of marketplace longevity.

The thoroughness and attention to detail that NAMM's Harris market research displays is indicative of how important computers had become to the musical instrument industry, but also how lost the industry was when dealing in non-traditional instruments. Throughout the 20th century, new technology had been the US instrument industry's home turf; now they were playing catch-up with rapid developments in computing, and competing with cheap and streamlined manufacturing practices in countries like Japan and Mexico. Inadvertently, the introduction and adoption of MIDI shifted the focus of consumers away from traditional instruments, and toward using different and previously unfathomable kinds of tools. Yet, MIDI did not singlehandedly enact changes in music making practices; a convergence of rapid innovation, and new digital technologies such as home computers and peripheral devices, accompanied the massive shift toward computer music making.

Undoubtedly, MIDI was at the center of a constellation of process innovations, but MIDI needed computers more than the computer business needed MIDI. Part of the reason behind its standardization was to gain acceptance in other sectors, but MIDI struggled to achieve indispensability. The same was true for the keyboard industry, which had been strong for over 300 years, and was now besieged to compete with virtual synthesis. To be sure, the kinds of customers that the emerging computer music business had to target – single, well-educated, young white men with a bit of money to burn – may not have been a big surprise. To a certain extent, they were the same kinds of customers who had been integral to the music business throughout the century. But the Harris poll helped put a finer point on exactly how to capture this most technologically savvy of musical generations yet. The key was the computer: equip everyone with them, and potential musicians would more easily turn into active musicians, and most importantly, regular consumers of new music technologies.

MIDI 2 Point Never

15 years after MIDI was inauspiciously first demonstrated at a NAMM show, and following the unprecedented surge in cheap keyboard buying that MIDI-capability carried through the 1980s, sales were in rapid decline. Popular music tastes had detoured into Grunge and Alternative Rock, genres that typically did not

include electronic instrumentation. And incoming pre-fab bands like the Spice Girls and Backstreet Boys played no instruments at all, generating zero peripheral interest in the traditional kinds of products that the music instrument industry had to offer. With electronic musicians consuming more computers and fewer instruments, the music manufacturing industry was in trouble. In 1998, NAMM responded by appointing a task force to figure out why MIDI had not expanded into 2 and 3.0 iterations the way other digital technologies traditionally did. Maybe a MIDI reboot would kick start spending in an ailing instrument sector.

Even though MIDI remained a loose agreement among manufacturers, and continued to generate additions inside its own original parameters, and despite complaints of increasingly rapid cycles of obsolescence, retailers still demanded the kind of turnover that would ensure increased profits, year after year. In short, MIDI did not outmode outmodedness. Perhaps the standard itself was not becoming obsolete fast enough. In turn, the keyboard industry got up to the old tricks of stalwart durable consumables like appliance and automobile manufacturers by releasing new models yearly, designing high-priced all-in-one machines, and creating exclusivity on a playing field leveled in part by MIDI. To a certain extent, long-term thinking is what brought MIDI about. Yet then, in a race to release the newest and most technologically advanced products, obsolescence was becoming a bigger obstacle. The PC industry was slowly backing away as well. Apple Computer's Howard Lieberman expressed blunt reluctance toward entering into any official agreement with the MIDI consortium for a Mac-based MIDI Operating System: "Why should we bother to expend any energy on such a small number [of clients]?" he asked in an October 1993 *Keyboard Magazine* article. "Apple has to figure out how to survive, not how to make 0.3% of its customer base totally happy."[356]

But, according to a prominent Op-Ed column from then-NAMM Chairman Gerson Rosenbloom, the computer and digital instrument community had "missed a golden marketing opportunity" by not actively pursuing updating and eventual replacement strategies for MIDI.[357] If the manufacturing industry could pull together once more to create a real replacement standard, it would be like the recording industry convincing everyone to re-buy *Dark Side of the Moon* on CD. To show their commitment to capitalizing on those missed opportunities, NAMM's new task force was willing to go dollar-for-dollar with researchers, to bring together disparate segments of the music instrument industry – to set up the meetings, rent the rooms, provide the nametags and donuts – and to aggressively sell whatever MIDI 2.0 might become to their growing base membership of retailers. On January 29th, 1999, at 8:30 a.m., the third (and final) NAMM MIDI Task Force Meeting – made up of high-ranking representatives from Hal Leonard, Northshore Marketing, Keyboard Magazine, Gand Music, Apple Computer, Opcode, Roland, and the MIDI Manufacturer's Association – came to order in Los Angeles, California. Beneath the broad aegis of NAMM's mission to "increase the number of active music makers" (read: 'to shift more units'), MIDI was being enlisted once again to resuscitate a stagnating trade like it did in the 1980s for home organs and analogue synthesizers – to bring back the good old Deus Ex 7 days.

Electronic keyboard sales increased roughly six-fold between 1980 and 1987; but by 1995, those figures fell by more than half.[358] One of the key reasons was that MIDI ensured 15-year-old machines would still work with their contemporary models. Synthesizer sales were also fast dropping off because, besides grungy guitars and basses, the market in music-making technology turned toward home computers. The digital instrument industry, which had become accustomed to being in the position of innovation, was now lagging behind and sought to quickly re-embed itself. NAMM's initial concept was to further consolidate the digital music-making business by officially bringing computer developers into the fold, making MIDI indispensable to the growing PC trade: they called it the "Trojan Horse" effect.[359] By aligning its standard with other industries, NAMM was attempting to further entrench MIDI into the digital musical ecosystem. But instead of making something more useful, NAMM was more focused on constructing something to replace what they had just made.

In a 1989 interview with Bob Moog, composer and then-MIDI Manufacturer's Association president Jeff Rona assured: "As far as the MMA is concerned, there will never be a MIDI 2.0."[360] And in 1990, Tom White was promptly installed as the MMA's new president, reflecting a fresh direction for the organization. White was a former retailer himself, and a strong advocate for marrying MIDI with computers, an idea he credits to Brian Vincik and Roger Clay of the IMA, who organized the first MIDI user groups.[361] MIDI was nowhere near as common in the mid-1990s computer business as it had become in the instrument game. It was the mainstay interface long used with various desktop computers for sequencing and notation; however, MIDI was never really thought of as a vital computer accessory. 5-pin jacks came with some sound-related computer cards and add-ons, but were more the terrain of expensive, dedicated and non-standard hardware. So, with White's help at the MMA's helm, the task force sought to encourage MIDI-reliant software and hardware design, and to market the results to tech-savvy professional musicians in hopes that they would stimulate trends in professional and, more importantly, potential amateur buyers. MIDI 2.0 would capitalize on the computer's popularity as MIDI 1.0 did on synths.[362]

But, between February and April 1999, amidst a flurry of correspondence, NAMM's then-Director of Marketing Development Joe Lamond unexpectedly reversed course, shifting responsibility for development back into the MMA's court, and instrument manufacturers at large. In an April 2nd email, White responded: "The whole point of involving NAMM was to get help soliciting support ... so it doesn't make much sense to turn back to us for the solicitation plan."[363] The next day, NAMM Chairman Rosenbloom reassured White – they would still make "each of their dollars become two" – but reiterated that the initial legwork of reaching out to individual manufacturers would have to be done by the MMA.[364] The MMA, though, faced its own staffing and funding problems, and was ill equipped to solicit from the spectrum of companies required to get behind MIDI's costly updates in any meaningful way. With each organization looking to the other for support, and with no focused and particular impetus from the computer or MIDI-user community, the task force and its project for 2.0 quickly died on the vine.

The MMA quietly went back to representing their same core manufacturers, and NAMM returned to its role representing the MMA within the larger international field of music merchants. Regardless of who was to blame, the electronic music community simply did not want or need MIDI 2.0 in 1999. NAMM's mythical missed marketing opportunity was by then unrecoverable. MIDI was barely a blip on most large computer and telecommunications corporations' radars – industries that tended to more quickly adopt new standards and protocols. Upstart software developers like Digidesign and Steinberg had already been focusing intently on integrating digital audio, virtual synthesis, and virtual studio technologies into their products. MIDI still wound up an integral part of the digital music-working environment, but it would do so through black-box interfaces, piggybacking on other kinds of standardized cables and connectors like USB, slaving to the software of the day. Digital instrument manufacturers continued installing 5-pin plugs on everything they made, but by the emergence of the new millennium, MIDI was far more the furniture than the architecture.

Conclusion

Manufacturers knew that the broad majority of electronic musicians wanted some kind of machine control, and overall, MIDI had enjoyed widespread acceptance by both manufacturers and players: by the mid 1980s, it had become a fact of life in the digital musical production environment. But after a surge in sales, the early 1990s saw a major drop in profits for music instrument retailers. NAMM countered by surveying dealers for the kinds of tools that might help them stimulate the stagnating trade.

Retailers unequivocally demanded that NAMM provide better literature on the basics of MIDI, in order to demystify the jargon around MIDI that dealers saw as an impeding force to its adoption. If retailers could not explain the products, chances were buyers were not interested. NAMM responded by producing brochures and pamphlets, like *Taking The Mystery Out Of MIDI*, to show prospective buyers that MIDI was not as intimidating at they might have thought – although the opposite was more often true. Manufacturers, too, were encouraged to make their manuals clearer, and even to create a new MIDI standard-within-a-standard, that would execute the simplest and most desirable functions of the interface. And in the early 1990s, General MIDI was born – a sort of MIDI-lite, specifically aimed at the novice and beginner user.

But another kind of user was concurrently emerging: the digital prosumer. More and more, buyers wanted the features of professional (and more expensive) technology, but the price and ease of something like a musical toy. Because of the rise of home computer sales, the development of more sophisticated software to sequence a series of machines, and eventually, the ability to edit and process digital audio, computers became the focus of both prosumers and the instrument industry. Companies like Digidesign began designing graphical user interfaces to be used as intermediary sound editing devices between samplers, drum machines, and computers. With digital audio, the "tapeless studio" took on a different meaning than it had under MIDI. Audio itself, and not simply trigger information, was being recorded, manipulated, stored, and retrieved from newer, faster, and less expensive computing machines – specifically, the Macintosh.

Again, NAMM turned its attention toward the computer industry, attempting to figure out how to market musical instruments to a new generation of PC users.

They wanted not only current but also future customers. Skill levels varied wildly between those for whom making music with MIDI and a computer seemed intuitive and inevitable, and those who were still struggling to figure out exactly what MIDI was supposed to do. Perhaps not surprisingly, the MIDI manufacturers had to appeal most to young, single, white men with above-average incomes and education – buyers who seemed to care less about price than the average consumer, but who were less willing to part with their money at all for something beyond their expertise. But markets were opening up too amongst more marginal groups – African American computer musicians, and religious organizations, for example.

By the late 1990s, MIDI had enjoyed status as the de facto standard digital interface for musical instruments for a decade and a half, and manufacturers started wondering if it might be time for an upgrade. With synthesizer sales stagnating, perhaps another new standard would stimulate musicians en masse to re-buy their gear, like they had done at the outset of MIDI. 1999 saw a glimmer of excitement that a radical update to the MIDI specification could be in the works. But limp initiatives from NAMM and the MMA were not enough to convince musicians (or the industry at large, for that matter) that MIDI 2.0 was necessary. And there was really no way to make MIDI as integral to computers as computers had become to MIDI. So, where did the MMA turn next? Ring tones. In the late 1990s, Tom White fought hard to have MIDI data included in every mobile phone, from every major manufacturer.[365] Thanks to this deal, we shall never want for the polyphonic version of “Get Ur Freak On” to alert us of an incoming call ever again.

Conclusion: Whither MIDI?

Standards and classifications are essential to the music instrument industry, and industry in general. And as digital technologies proliferate through daily life, interoperability has emerged as a central concern for technological innovation. With more and more music-making devices entering the marketplace, a need arose to make them function together. Particularly, the musical instrument trade was an especially apt prototype for all sorts of subsequent industry standards.

At the dawn of the 20th century, American piano manufacturers organized for a common purpose, to stabilize and expand their own business, establishing a guild for their trade, and creating certain manufacturing standards, classifications, and operations protocols within the industry. Those standards were actually conceived of on a much longer continuum of claviocentric touchstones, beginning with the clavier keyboard, the twelve-tone musical scale, equal temperament, and the separation of the continuous audible spectrum out into discrete and measurable, triggerable notes. The contemporary piano is really more of a musical machine than an instrument, and standardizing its manufacture dovetailed with a shift toward mass-production of consumer durables, and the industrial cultural logic of modernity. And claviocentrism itself was the cultural logic that guided musical keyboard technology toward automatic pianos, home organs, synthesizers, and eventually, to MIDI.

At the same time, the idea of making and playing music was in the process of evolution. The piano gradually shifted from being an instrument of utility into a consumer commodity, and credit-purchasing systems helped stimulate massive sales in the US and abroad. Piano lessons became associated with higher social status and class, and music education was co-opted into a national musical character-building project. At the other end of the spectrum, music was increasingly becoming an individual, leisure activity. The concept of acquiring musical skill gradually turned from laborious and social practice toward developing solo technological prowess – from the piano roll up to MIDI-enabled instruments. The rhetoric around musical technology of the 20th and early 21st century has revolved around one person's ability to do it all, to create entire orchestras by themselves, to be Beethoven with a synthesizer rather than a symphony.

In the mid-20th century, as electric organs proliferated through the popular musical landscape, musically-minded engineers like Bob Moog entertained the concept of synthesizing sound, and built synthesizers around the claviocentric model. Progressive Rock and Jazz artists took up the instruments, incorporating them into their studio and stage set-ups, mutually stimulating developments in musical aesthetics and technological innovation. Practical issues, however, like the limited number of sounds a given synthesizer could produce at once, and their often-enormous size and weight, stimulated the concept of integrating multiple instruments together. In America, Sequential Circuits, E-mu, and Oberheim had developed proprietary systems for centrally controlling their own instruments. And Bryan Bell had constructed an elaborate digitally automated studio interface for Herbie Hancock, five years prior to MIDI. But no one had generated consensus about the need for a universal manufacturer interface.

The MIDI specification was encouraged and cultivated under the guidance and facilitative assistance of NAMM and other industry consortiums, and did for the synthesizer business in the 1980s what standardizing piano rolls did for player piano manufacturers at the turn of the century. Akin to player piano roll regulation, keyboard manufacturers themselves constructed MIDI through the basic agreement and cooperative desire to expand their business. Once the specification was announced, clusters of individual agents gathered around the MIDI protocol to try and shape it to their requirements and demands. But the collaborative discursive field afforded by NAMM proved also to be a site of closure, terminating discussion of the specification once MIDI achieved critical mass in the synth business. Once millions of MIDI-capable instruments began shipping, locking down the spec was in the industry's interest.

But MIDI was an anti-standard in lots of ways. It was adopted and implemented so quickly that officially standardizing with the American National Standards Institute would have effectively meant starting again from scratch. As well, once the specification was established, both Japanese and American MIDI associations virtually gave the coding away for free to those wanting to build it into their instruments. The MIDI Manufacturers Association in the US, and the Japanese MIDI Standards Committee, took responsibility for distributing MIDI information far and wide. And other associations, like the International MIDI Association, spun off into user groups and amateur forums for MIDI-related discussion. Free distribution subsequently became a staple business practice in consumer electronics and computers, with bundling and software suites becoming more and more commonplace, fast tracking general adoption.

Doing-it-all-yourself generated problems among professional musicians and American labor organizations, however, and an anti-technology backlash formed against synthesizers and MIDI in the early 1980s. The pioneering San Francisco organist Don Lewis' blacklisting by the American Federation of Musicians in 1984, and mounting legal concern over the ethics around music performance and recording put the labor debate's seriousness in sharp relief. Digital sampling collapsed and remapped every potential sound onto the clavier console. And realistic-sounding instrument patches, developed by companies like Sequential Circuits, Yamaha, and Korg made it possible to command any instrument imaginable with the synthesizer keyboard. Preset sound patches subsequently became the dominant voices in popular songs, homogenizing the sound of electronic music. But into the 1990s, after a decade of exponential growth, various factors including widespread confusion about MIDI technology and changing tastes in popular music redirected the instrument industry away from buying synthesizers.

After MIDI-related sales started stagnating, NAMM and the music products industry began taking a closer look at what music retailers and technology users thought. NAMM commissioned several surveys, compiling granular information on the retailers' attitudes, and the demographics of potential markets for digital music technologies. Dealers felt that MIDI was fine for technology-conversant professional musicians who knew their way around digital devices, but amateur musicians – the industry's bread and butter – felt the lingo around MIDI was too confusing. Even though it was a standard that synthesizer manufacturers intended to bring order and interoperability between their instruments, it often did not work that way on the ground. And so, like the easy-does-it argument about the player piano, NAMM set to work trying to convince wary buyers how simple and useful MIDI actually was, while manufacturers introduced General MIDI, a streamlined version of the spec, and new lines of instruments designed for the novice musician.

Approaching the new millennium, more and more electronic musicians were incorporating computers into their MIDI ecosystems, and NAMM sought to work more closely with certain segments of the computer industry. Falling prices for digital memory, and increasing processing speeds meant that computers could handle greater volumes of digital information. Advancements in digital audio recording, editing, and processing, with software and hardware systems like Digidesign's ProTools threatened MIDI's claim to the tapeless studio. In a last ditch effort, NAMM and the MMA wondered whether a new version of MIDI could finally and permanently unify the computer and digital musical instrument markets. But MIDI had become just one of many operative modes for making digital music, blending into the background of the computer music technology ecosystem.

When I asked him for comment on MIDI's 30th anniversary, Trevor Pinch mused: "Of course, MIDI enabled a whole new generation of digital musical artists to emerge. It made equipment cheaper and more affordable, and I love electronic music enough to cherish that."[366] I do too. And despite the backroom nature of many of MIDI's milestones, I believe that a genuine love of both music and technology brought MIDI to life. Mountains and moguls in the synthesizer industry rose and fell in the process, but the fact that MIDI is still in use today, in nearly every recording studio and in every mobile phone, is the best argument that creative industries are more apt to effective self-regulation. MIDI still helps make great music.

Some players, like Roland and Yamaha, took the fast track with MIDI, churning out low-cost mass-produced synthesizers; others, like Tom Oberheim and Dave Smith, were forced into the slow lane, and are only now starting to regain their footing in the electronic musical instrument trade. And perhaps corporate giants and computer companies reaped the most benefits from the MIDI standard, but nobody made a fortune directly from selling the specification. Yet, even though Sequential Circuits freely distributed the protocol literature, and was eventually gobbled up by Yamaha at the end of the '80s, Dave Smith still landed on his feet. "MIDI was done by synthesiser companies," he reminded me in our 2013 interview. "Our main goal was for our own industry to grow. MIDI certainly scored well in that department, and we all sold a lot of instruments."[367]

Notes to Introduction:

[1] Kamp and Daly, (2005), pp. 72-3.

[2] Jeff Rona, NAMM Oral History Interview, 20 January 2005.

[3] Ibid.

[4] Trond Bratten Archive, NAMM, Carlsbad, California, (2014).

[5] In 2013, MIDI's 30th anniversary, NAMM devoted a large section of their Museum of Making Music to a MIDI exhibit. They also partnered with the MMA to host a series of MIDI-related events throughout the year.

[6] *MIDI Revolution*, DVD transcript, MMA Box, NAMM, Carlsbad, California. p. 23.

[7] Moore, (1988), 19.

[8] Ibid.

[9] See Acland (2006), and Maxwell and Miller (2012) on obsolescence and waste.

[10] Politis et al, (2008), 48.

[11] Yavelow, (1986); Belkin, (1994).

[12] See Curtis Roads, (1989), pp. 179-253.

[13] Mumford, (1934), p. 344.

[14] Galloway, (2006).

[15] Fuller, (2007).

[16] Bowker and Star, (2000); Lampland and Star, (2008).

[17] Dolge, (1911, 1972); Ord-Hume (2004, 2007).

[18] Pinch and Trocco, (2002).

[19] Théberge, (1997); (2004). Also, Waksman (1999) on the electric guitar industry; and Pinch and Bjisterveld (2004) on music and technology.

[20] Théberge, (1997), pp. 145-53.

Notes to Chapter 1:

[21] "The Lady who Swings the Band" (Cahn, Chaplin), from *Mary's Idea*, Andy Kirk and Mary Lou Williams. Decca Records, 1936.

[22] Ibid.

[23] Ibid.

[24] Théberge, (1997), 20.

[25] Dolge, p. 28.

[26] Sullivan, (2005), p. 39.

[27] Ibid, p. 37-8.

[28] Ibid, p. 21.

[29] See Mowitt (2002) pp. 27-34 on the piano's role in Rock n' Roll's "backbeat."

[30] Dolge, p. 29.

[31] Russell, (1997), p. 177.

[32] Crowest, (1881), p. 200-201.

[33] Russell, (1997), p. 55.

[34] Ibid, p. 57.

[35] Seeger, (1957), p. 283.

[36] Ibid, p. 285. Seeger furthermore notes that the "small vanguard of private citizens" were Freemasons: "Lowell, b. 1792 and William, b. 1829, Theodore Thomas, b. 1835 and the Damrosches Leopold, b. 1832, Frank, b. 1859 and Walter, b. 1862."
[37] Ibid.
[38] Zeilinski, p. 127.
[39] Ibid, p. 125.
[40] Ibid.
[41] Britten, (1904), p. 354-5
[42] Mumford, (1934), p. 14.
[43] Ibid, p. 15.
[44] Ibid.
[45] Ord-Hume, (2007), p. 86.
[46] Ibid, p. 54.
[47] Maxwell, (2007), p. 288.
[48] Ord-Hume, (2007), p. 86.
[49] Martin, (1988). See also Jackson on metronomy, in Pinch and Bijsterveld, (2011)
[50] Stadlen (1967), 330.
[51] Merrick, (2004).
[52] Wotton, (1930), 220.
[53] See Kiri Miller (2009 and 2012) on Guitar Hero and ideas around music, games, authenticity, practice, and performance. As well, see Mark Butler's (2006) discussion of records, tempo, and beat matching.
[54] Dolge, (1911), 134.
[55] Ord-Hume, (2004), p. 162. See also, http://www.pianola.org/history/history_inventors.cfm
[56] Ibid, p. 153.
[57] Ibid, p. 409, 426.
[58] Ibid, p. 383. See also, http://www.pianola.org/factsheets/apollo.cfm
[59] Théberge, (1997), p. 29; Majeski (1990), p. 52.
[60] Ibid.
[61] Ibid, 28; Roell (1989), p. 155.
[62] Dolge, p. 410.
[63] Ibid.
[64] Ibid.
[65] Ibid, p. 411.
[66] See Pegley (2006); Kiri Miller, *Playing Along*, (2012).
[67] Marchand, (1985), pp. 140, 142.
[68] Théberge, (1997), p. 29; Roell (1989), p. 156-59.
[69] Ibid, p. 45.
[70] Ibid.
[71] Ibid, p. 47.
[72] Roland Corporation Collection, NAMM Archives, Box 1.
[73] Dennis Houlihan LP collection, NAMM Archives, accessed March 3rd 2014.
[74] Théberge, (1997), p. 52.

[75] Pinch and Trocco, (2002), p. 43.
[76] Bob Moog Interview, NAMM Oral History Program, 21 January 2005.
[77] Théberge, (1997), p. 52.
[78] Historical notes, Roland Corporation Collection, Box 1, NAMM Archives.
[79] One notable exception is the comprehensive history of Roland, with biographical details on Kakehashi, published between November 2004 and March '05 in *Sound On Sound* magazine. See: http://www.soundonsound.com/sos/nov04/articles/roland.htm
[80] Ikutaro Kakehashi NAMM Oral History Interview, 31 January 2001; 24 January 2005.
[81] Ibid.
[82] Ibid.
[83] Ibid.
[84] Ibid.
[85] Pegley (2006); Ajero, (2007)
[86] Cuban, (1986).
[87] Moog, (1986).
[88] Mueth (1994), 53.
[89] Ajero, (2007).
[90] Pegley, (2006).
[91] Ajero, p. 58.
[92] Ibid, p. 102-3.
[93] Ibid, p. 103.
[94] Ibid, 103-4.
[95] See Massey, *Taking The Mystery Out Of MIDI*. NAMM, (1992).
[96] Pegley, (2006).
[97] Ibid, p. 60.
[98] Ibid.
[99] Ibid, p. 63.
[100] Ibid, p. 67.
[101] Massey, (1992).
[102] Ibid, p. 1.
[103] Ibid.
[104] Mueth, (1993), p. 49.
[105] Ibid.
[106] See, for example, *Democracy Now*'s interview with Questlove of The Roots: http://www.democracynow.org/blog/2013/8/14/questlove_on_how_stevie_wonder_the_cosby_show_helped_shape_modern_hip_hop
[107] Gann, (2006), p. 49.
[108] Ibid.
[109] See Connor, "The Impossible Music of Black MIDI, " *Rhizome*. 23 September 2013. http://rhizome.org/editorial/2013/sep/23/impossible-music-black-midi/
[110] Barry, (2014).
[111] Sullivan, p. 21.

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112 Bryan Bell, NAMM Oral History Interview, 21 January 2005.
113 http://www.namm.org/library/blog/namm-oral-history-10th-anniversary
114 Tom Bateman, "How MIDI Changed the World of Music", *BBC Today Programme*, http://www.bbc.com/news/technology-20425376
115 John Bowen, NAMM Oral History Interview, 18 January 2007.
116 Théberge being a notable exception.
117 Waksman, (1999), pp. 1-4.
118 Rick Wakeman, NAMM Oral History Interview, 12 July 2013.
119 Keith Emerson, NAMM Oral History Interview, 29 August 2009.
120 Bell, (2005).
121 Ibid.
122 Ibid.
123 Ibid.
124 Herbie Hancock NAMM Oral History Interview, 21 January 2006. Despite a promise to Apple Records that it would not enter the music business, Apple Computer in particular was heavily involved in digital musical instruments and software development during MIDI's early days. PC users were figuring out ways of modifying IBM hardware to function as MIDI interfaces. See the IMA Bulletin, February-March 1984, pp 1, 9.
125 Bell, (2005).
126 This is taken to the extreme in examples like Aphex Twin's "Monkey Drummer" from 2001, and 2014's *Music For Robots* album by Squarepusher, in which animatronics are used to trigger both electric and acoustic musical instruments via MIDI.
127 Tom Oberheim, NAMM Oral History Interview, 22 January 2012.
128 Ibid.
129 Pinch & Trocco, (2002), p. 270.
130 Oberheim, (2005).
131 Ibid.
132 http://www.redbullmusicacademy.com/lectures/tom-oberheim-polyphonic-one-love
133 Dave Rossum and Scott Wedge, NAMM Oral History Interview, 21 January 2007.
134 Bowen (2007).
135 Dave Rossum, Personal Interview, 7 July 2014.
136 Ibid.
137 Ibid.
138 Ibid.
139 Ibid.
140 Ibid.
141 Marco Alpert, Personal Interview, 30 June 2014.
142 Don Lewis, NAMM Oral History Interview, 22 December 2002.
143 Ibid.
144 https://www.youtube.com/watch?v=7_4Jd1__Bec
145 See Pinch and Trocco, (2002), p. 148; Théberge, (1997), p. 195.

[146] Jalon, (1985).
[147] Ibid.
[148] Lewis, (2002).
[149] Bowen, (2007).
[150] Ibid.
[151] Ibid.
[152] Ibid.
[153] Ibid.
[154] Ibid.
[155] Ibid.
[156] Ibid.
[157] Ibid.
[158] John Chowning, NAMM Oral History Interview, 20 January 2005.
[159] Ibid.
[160] Ibid.
[161] Ibid.
[162] Ibid.
[163] See archive: http://yates.ca/dx7/AfterTouch-Magazine/
[164] Ibid. See also, Hancock, (2006), for a discussion of the ill-fated Syntauri Corporation.
[165] Chowning, (2005).
[166] Lewis, (2002).
[167] Tsutomu Katoh, NAMM Oral History Interview, 16 October 2006.
[168] Ibid.
[169] Wakeman, (2013).
[170] Katoh, (2006).
[171] Jack Hotop and Jerry Kovarsky, NAMM Oral History Interview, 20 January 2005.
[172] Ibid.
[173] Ibid.
[174] Ibid.
[175] Moog, quoted in Johnson, (1987).
[176] Percifull, (1992), pp. 1268-9.
[177] Johnson, (1987), p. 279.
[178] Ibid.
[179] Ibid, p. 276.
[180] Michael W. Miller. "High-Tech Alteration Of Sights and Sounds Divides the Arts World." *Wall Street Journal.* 1 September 1987.
[181] Swapping out sounds – particularly in drum machines – was the impetus for the creation of Digidesign, as we shall see in Chapter 4.
[182] Nate Harrison (2004) chronicles the history of the "Amen Break," a ubiquitous drum loop featured on several Hip-Hop and Jungle recordings. http://nkhstudio.com/pages/amen_mp4.html
[183] Kohn, (2010), p. 770.
[184] Hancock, (2006).
[185] Wakeman, (2013).

[186] In *Music, Society, Education*, (1996), p. 19, Christopher Small discusses the elements of musical composition as the raw material conceived first by the composer, "to be clothed only later in instrumental sounds."
[187] Enders in Braun (2002), p. 231.
[188] Bell, (2005).
[189] Percifull, (1992), p. 1263.
[190] Braun, (2002), p. 15.
[191] See website: http://www.synthbank.com/
[192] See Moog's press release: http://www.moogmusic.com/news/moog-music-announces-new-emerson-moog-modular-system

Notes to Chapter 3:
[193] Kittler, in Johnston (1997), p. 121.
[194] Bowker and Star (2000), p. 4.
[195] Bowker and Star, (2000), p. 13.
[196] Moog (1986) p. 394.
[197] Bowker and Star, (2000), p. 13.
[198] Ibid, p. 14.
[199] Ibid.
[200] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[201] Bowker and Star, (2000), p. 14.
[202] Ibid.
[203] See Strauss et al., (1985).
[204] Bowker and Star, (2000), p. 44.
[205] Pinch & Oudshoorn, (2003), p. 1.
[206] Dan Del Fiorentino, personal interview, Carlsbad, California. 6 March, 2014.
[207] Ibid.
[208] See NAMM's website on its "Circle of Benefits" http://www.namm.org/about/circle-of-benefits
[209] Moog, (1986).
[210] Bryan Bell, NAMM Oral History Interview, 21 January 2005.
[211] Pinch and Trocco, (2004), p. 109.
[212] Ikutaro Kakehashi, NAMM Oral History Interview, 24 January 2005.
[213] Tom Oberheim, NAMM Oral History Interview, 24 January 2005.
[214] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[215] Dave Smith, NAMM Oral History Interview, 19 January, 2005.
[216] Ibid.
[217] Ibid.
[218] Ibid.
[219] Ibid; John Bowen, NAMM Oral History Interview, 18 January, 2007.
[220] Both Smith and Oberheim claimed that making synthesizers was the ideal combination of their passions for music and technology.
[221] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[222] Ibid; Brian Vincik, Personal Interview, 6 March 2014.
[223] Ibid.

[224] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[225] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[226] Ibid.
[227] Brian Vincik, Personal Interview, 6 March 2014.
[228] Ibid. The original proof of publication is housed in Box 1 of the Brian Vincik archives, NAMM Resource Center, Carlsbad CA.
[229] DeGenova, (1984), p. 27.
[230] Roger Clay. "What are we here for?" Editorial, *IMA Bulletin*, December 1984, p. 2.
[231] David C. Droman, "Exploring MIDI." *IMA Bulletin*, February 1985, p. 7.
[232] IMA Box 1, NAMM Resource Center, Carlsbad, CA.
[233] Milano, "Turmoil in MIDI-Land", *Keyboard*. June 1984. p. 42.
[234] Ibid, p. 43.
[235] Ibid; Dave Rossum, Personal Interview, 7 July 2014.
[236] Ibid, p. 44.
[237] Diduck, (2013).
[238] IMA Steering Committee Letter of Purpose and Introduction, 31 January, 1984. IMA Box 1, NAMM Resource Center, Carlsbad, CA.
[239] Jim Smerdel - Committee Members Personal Correspondence, 3 June 1984. IMA Box 1, NAMM Resource Center, Carlsbad, CA.
[240] Born, (1995), p. 284.
[241] Ibid.
[242] *MIDISoft Conference Brochure*, Brian Vincik files, NAMM, accessed 6 March 2014.
[243] "An Open Letter from Gareth Loy." *IMA Bulletin*, Summer 1984, p. 2.
[244] DeGenova, (1984), p. 27.
[245] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[246] "MIDI Joins ANSI." *IMA Bulletin*. February-March 1985, pp. 3, 12.
[247] Musical Information Processing Standards CFP, 1985, Brian Vincik files, NAMM, accessed 3 March 2014.
[248] Jeff Rona, NAMM Oral History Interview, 20 January 2005.
[249] JEMIA-IMUG Personal Correspondence, 1 October 1983. IMA Box 1, NAMM, Carlsbad, CA.
[250] JEMIA-IMUG Personal Correspondence, 8 November 1983. IMA Box 1, NAMM, Carlsbad, CA.
[251] Ibid.
[252] Ibid.
[253] IMA-JEMIA Correspondence, 29 February 1984. IMA box 1, NAMM, Carlsbad, CA.
[254] Moog, "MIDI: What it is, What it means to you." *Keyboard*. July 1983, p. 21.
[255] DeGenova, (1984), p. 26.
[256] Ibid, p. 27.
[257] Rogers, "RAM-a-Lam-a-Ding-Dong." *Newsweek*. 28 May 1984, p. 89.
[258] Milano, (1984), p. 42.
[259] *IMA Bulletin*, November 1986, p. 2, 8. IMA Box 1, NAMM, Carlsbad, CA.
[260] Ibid, p. 8.
[261] *IMA Bulletin*, October-November 1989, p. 5. IMA Box 1, NAMM, Carlsbad, CA.

[262] "Music USA". *American Musical Conference Statistical Review*. (1988), p. 4. NAMM Resource Center, Carlsbad, CA.
[263] Ibid, p. 8.
[264] Ibid, p. 12.
[265] Ibid.
[266] Ibid, p. 16.
[267] Ibid, p. 21.
[268] Théberge, (1997), p. 151.
[269] Milano, (1984), p. 44.

<u>Notes to Chapter 4:</u>
[270] Gerson Rosenbloom, "MIDI Task Force Looks at the Future of Music Tech." *NAMM Show Program,* 1998.
[271] Music USA, p. 18-19.
[272] Ibid, p. 11.
[273] "Music Retailer MIDI Attitude Survey," NAMM & Loft Marketing, (1992).
[274] Ibid, p. 1.
[275] Ibid.
[276] Ibid, p. 2.
[277] Ibid, p. 3.
[278] Ibid, p. 4.
[279] Ibid.
[280] Ibid, p. 18.
[281] Ibid.
[282] Ibid, p. 19.
[283] Bryan Bell, NAMM Oral History Interview, 21 January 2005.
[284] Ibid, p. 5.
[285] Ibid.
[286] Ibid, p. 6.
[287] Ibid, p. 7.
[288] Ibid, p. 9.
[289] Ibid.
[290] Ibid.
[291] Ibid.
[292] Ibid, p. 12-13.
[293] Ibid, p. 16.
[294] Ibid, p. 22.
[295] Ibid.
[296] Ibid, p. 24.
[297] Massey, *Taking The Mystery Out Of MIDI*. NAMM (1992), p. 2.
[298] Ibid.
[299] Ibid.
[300] Ibid, p. 4.
[301] Ibid.
[302] Ibid.

[303] Ibid, p. 5.
[304] Ibid, p. 7.
[305] Ibid, p. 12.
[306] Ibid, p. 14.
[307] Ibid, p. 15.
[308] Ibid, p. 16.
[309] Ibid, p. 17.
[310] Ibid, p. 26.
[311] Rothstein, (1992), p. 102.
[312] Evan Brooks, NAMM Oral History Interview, 27 January 2013.
[313] Ibid.
[314] *Making Music With The Computer*. NAMM: (1995), p. 7.
[315] Ibid.
[316] Ibid, p. 9.
[317] Ibid.
[318] Ibid.
[319] Ibid, p. 10.
[320] Ibid.
[321] Ibid, p. 11. For an in-depth analysis of gender in electronic music, see Rodgers, (2010).
[322] *Making Music With The Computer*. NAMM: (1995), p. 11.
[323] Rodgers, (2010), pp. 37, 216.
[324] Ibid.
[325] Ibid, p. 14, 20.
[326] Ibid, p. 13.
[327] Ibid, p. 14.
[328] Ibid, p. 22.
[329] Ibid, p. 25.
[330] Ibid, p. 29.
[331] Ibid, p. 22.
[332] Ibid, p. 23.
[333] Ibid.
[334] Ibid.
[335] Ibid.
[336] Ibid, p. 24.
[337] Ibid, p. 33.
[338] Ibid, p. 39.
[339] Théberge, (1997), pp. 128-9.
[340] Ibid.
[341] Ibid.
[342] Ibid.
[343] Ibid, p. 40.
[344] Ibid.
[345] Ibid.
[346] Ibid.

[347] Ibid, p. 41.
[348] Ibid, p. 47.
[349] Ibid, p. 48.
[350] Ibid.
[351] Ibid, p. 49.
[352] Ibid, p. 55.
[353] Ibid.
[354] Ibid, p. 65.
[355] Ibid, pp. 60-62.
[356] Marans, (1993).
[357] Rosenbloom, (1998).
[358] "The Synthesizer Market and Unrealized Potential," *Music Trades*, November 1996, p.99.
[359] MIDI Task Force Correspondence, Feb-Apr 1999.
[360] "You've come a long way, MIDI." *Keyboard Magazine*, February 1989, p.117.
[361] Tom White, NAMM Oral History Interview, 27 January 2013.
[362] MIDI Task Force Meeting Notes, Nashville, 13 July 1998. NAMM Resource Center.
[363] MIDI Task Force Correspondence, Feb-Apr 1999. NAMM Resource Center.
[364] Ibid.
[365] Tom White, NAMM Oral History Interview, 27 January 2013.

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[366] Diduck, (2013).
[367] Ibid.

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