

**Evaluating the Effects of MIDI on the Recording and
Composing Process**

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INTRODUCTION

MIDI, or Musical Instrument Digital Interface, is a computer language involving hardware and software that has been around since 1983. It set a standard for the communication of data between synthesizers¹ and computers. The creator, Dave Smith (1950- present), made this technological breakthrough free for public use, resulting in a boom of electronic musical recordings.²

A wealth of information exists regarding MIDI and how the interface functions. There is also no question that MIDI has changed the recording and composing process of the music industry forever. Yet there is little study done on how this was accomplished. This dynamic relationship between music and technology has largely gone unnoticed by musical scholars. This research will fill the gap that exists between physical technological accomplishments and how they impact processes and products. One issue that could arise is finding enough scholarly information regarding the significance of MIDI. Many sources describe mechanically what MIDI is as a tool, but fail to go further and say how it interacts with its users. Finding out how MIDI has impacted aspects of the music industry is a challenge that covers a broad subject. Extensive research and interviews will help overcome these challenges.

The goals of this paper are to analyze MIDI's effect on the composing and recording process, and to find the scale of its impact on the music industry. MIDI has

¹ "A synthesizer (or synth) is an electronic instrument that uses multiple sound generators to create complex waveforms that can be combined (using various waveform synthesis techniques) into countless sonic variation." They "generate sounds using a number of different technologies or program algorithms." Some are meant to sound synthetic, while others "...mimic instruments..." (Huber, 1999, 58).

² Sami Yenigun. "The MIDI Revolution: Synthesizing Music For The Masses." NPR, NPR, 12 May 2013, www.npr.org/sections/therecord/2013/05/12/182874125/the-midi-revolution-synthesizing-music-for-the-masses.

undoubtedly reinvented the process of making music, but this paper aims to answer how and to what extent it has affected the careers of composers and audio engineers. This paper also intends to find the prevalence of MIDI and discuss the advantages and disadvantages that it has on music. The conclusion will offer insight into the future development of this technology. This paper's coverage will be limited to describing MIDI as it relates to music, but it should be noted that "today, MIDI is used for many applications including lighting, multimedia, for ringtones, and in theme parks."³

In order to determine MIDI's impact, this paper will use research to compare the music production process before and after the founding of this computer communication language. Interviews with composers and recording engineers will provide firsthand insight into how their careers were altered after MIDI was introduced. By investigating the new possibilities and changes in procedure, the paper will find how MIDI managed to affect that process. Finally, the paper will weigh the benefits or disservices of this technology and how it may evolve in the future.

MIDI has changed music as well as the production process; now there are new types of music that were not possible before the integration of this technology. MIDI gave artists new opportunities and the power to surpass their compositional, recordable, and instrumental limits. Today, some hit songs are entirely produced using MIDI and synthesizers. 1983 marked the beginning of a new era in sonic technology. This paper examines the effect of MIDI on the composing and recording process, and how it achieved this impact.

³ Richard James Burgess. *The History of Music Production*. N.p.: Oxford UP, 2014. Print. 130.

CHAPTER 1: MIDI

What is MIDI

What exactly is MIDI? Is it a type of music or a specification of technology? Typically "...when we say MIDI we almost automatically think about computers," but "that's not the whole picture."⁴ There are many misconceptions as to what it is, what it does, and how it works. MIDI is an acronym for Musical Instrument Digital Interface. It is a digital language that permits communication between computers and music-making devices. It converts musical and performance related events, such as pitch and volume, into a numerical language of data messages that allow multiple electronic instruments to share information with a computer and with each other. MIDI refers to two components: "a set of commands, or the MIDI 'language,' and the details for the electrical way those commands are transmitted and received."⁵ In other words, it is "a hardware and software standard established in 1983 for communication of musical data between devices such as synthesizers, drum machines and computers."⁶

This digital language allows compatible hardware to exchange messages within one "connected network."⁷ The hardware involved is often a single MIDI cable. One simple connection is all that is needed for MIDI's single line of data to be transferred since "the basic MIDI protocol provides up to 16 independent channels of information..."⁸ These data sets, or messages, are transmitted from their source (such as a

⁴ Sarah Lambert, and Steve MacLean. "Working with MIDI." 20 Oct. 2017.

⁵ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. N.p.: Amsco Publications, 1993. Print. 11.

⁶ David Burnand. "MIDI." *The New Grove Dictionary of Music and Musicians*. Ed. Stanley Sadie. Vol. 16. N.p.: Oxford UP, 2001. N. pag. Print. 345.

⁷ David Miles Huber. *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. N.p.: Focal, 1999. Print. 58.

⁸ David Miles Huber. *The MIDI Manual*, 58.

keyboard) and are then “recorded into a hardware device or software program ... where they can be edited” in a computer and create sound.⁹ In this way MIDI can make multi-track recordings that are different than audio recordings. The information in a MIDI track is not fixed in pitches or duration; it can be edited after its inception. All musical information such as performance parameters or control changes can be saved, edited, and repeatedly played through a computer or electronic instrument. In this way, MIDI opens up a new medium for sharing, editing, and producing music.

MIDI has a variety of additional functions that operate together to create a compositional tool. It can be used to digitally imitate instruments, edit performances, and combine multiple tracks to thicken the sound quality. MIDI also allows the user “to create effects such as delays using different instruments, to synchronize devices such as sequences, drum machines and video, using MIDI time code,” and “to automate mixing processes, such as fades and mutes.”¹⁰ Therefore, MIDI can achieve more than is possible in a live performance.

There are a number of misunderstandings and misconceptions about MIDI. First, it is not music itself; it simply conveys musical information that allows another device to create the identified sound. Another misunderstanding comes from its name. The “I” in MIDI stands for ‘interface,’ and yet “...an interface is usually defined as a hardware device that translates one form of data representation into another.”¹¹ However, the MIDI specification does not involve a conversion of formats, but rather a “protocol for the transmission and reception of music data.”¹² Another topic of confusion is calling MIDI a

⁹ David Miles Huber. *The MIDI Manual*, 58.

¹⁰ David Burnand. "MIDI." 1-2.

¹¹ David Miles Huber. *The MIDI Manual*, 268.

¹² David Miles Huber. *The MIDI Manual...*, 268.

‘standard.’ This term can imply that MIDI has legal standing, yet “...MIDI has no basis in law at all.”¹³ There is no rule for manufactures that they must comply with MIDI, even though most companies make sure their equipment follows the specification so that MIDI devices can be compatible. Finally, the “M” for music in MIDI’s name leads one to believe that it is solely a musical language. Although its primary use is in music production and composition, MIDI soon evolved to control stage lighting and other synchronized elements in live performance.

How MIDI Functions

Examining the hardware involved, we start with the MIDI data cable through which “...all information is channeled into a single stream of bits.”¹⁴ At the end of the cable is a 5-pin DIN socket (see figure 1).¹⁵ There are

three types of MIDI ports you can plug the cable into: MIDI OUT, MIDI IN, and MIDI THRU. MIDI OUT

ports can be seen on instruments like keyboards, as they send MIDI information out. Synthesizers and samplers may

have an additional MIDI THRU port to “both send and receive information.”¹⁶ MIDI IN ports accept data, and can be seen in the back of a mixing board.

What kinds of information are stored in these bytes of data? When a key on a keyboard is struck, it sends a MIDI message to the connected computer. That message



Figure 1: MIDI Keyboard Jack

¹³ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 11.

¹⁴ Peter Manning. *Electronic and Computer Music*. N.p.: Oxford UP, 2004. Print. 268.

¹⁵ “Molded Cable, Mini DIN 8 Male / Male, 10.0 Ft - DK238MM-10.” L-Com Global Connectivity, L-Com Inc., www.l-com.com/firewire-din-scsi-sata-molded-cable-mini-din-8-male-male-100-ft.

¹⁶ Peter Manning. *Electronic and Computer Music*, 269.

contains three bytes of data. The first byte identifies the start or end of a command, the second byte identifies the pitch, and the third determines the velocity of the note played. The duration of the note is not transmitted; each “note on” message is followed by a “note off” message when the key is released (made of the same three-bytes). MIDI is the chosen numeric values that correspond to the given musical information. Computers speak in numbers, so MIDI is a standard of numbers. For example, the middle C pitch has a value of 60 while concert A is 69 (as it is nine semitones above middle C). If a keyboard does not have a range of velocities, MIDI gives a constant value of 64. All values in each byte “...must lie in the range 0 to 127, for MIDI only allows the use of seven bits per byte for the storage.”¹⁷ The two numbers that make up a bit, multiplied to the seventh, give us 128 numerical options: 0 to 127.

Another type of MIDI message is one that allows for later editing. These are called ‘key pressure’ or ‘after-touch’ messages. This kind of data can edit the velocity values of the played notes. It is made up of two or three bytes depending on whether the equipment can differentiate between the depressed keys: the status byte, the optional byte containing the note number, and the third byte with the pressure value. Again, these values fall within the 0 to 127 scale.¹⁸

MIDI “solved the problem of standardization in the handling of data which continues to plague the rest of the computer industry, and together with the progress and decreasing cost of microprocessors and miniaturization, radically altered the mode of production of music in the process.”¹⁹ Together with samplers and sequencers,²⁰ MIDI

¹⁷ Peter Manning. *Electronic and Computer Music*, 270.

¹⁸ Peter Manning. *Electronic and Computer Music*, 271.

¹⁹ Michael Chanan. *Repeated Takes: A Short History of Recording and its Effects on Music*. Verso, 1995. 161.

moved much of the music-making process from live performance to the computer. Writer Jeremy Beadle (1948-2008) said that “Once upon a time if you wanted a decent rhythm track, you had to play it, or hire session men to play it for you...” but “with a sampler and a sequencer, two bars of a basic beat is more than a luxury; it’s a positive extravagance.”²¹

Author Andrew Blake (1952- present) noted that artist “Holly Johnson’s (1960-present) voice was sampled a few times singing a few words, the rest of the band did little or nothing, and the magic fingers of producer Trevor Horn (1949- present) did the rest...”²² Together they remixed seven different versions of the hit 1984 single *Relax*. All of the songs included brief clips of original vocals, instrumentalists, and edited drum samples from the original CD.²³ This kind of song creation via editing was made possible by MIDI. Before the protocol was standardized, music production was limited to the original tracks with performance errors.

CHAPTER 2: BEFORE MIDI AND ITS INTRODUCTION

Life Before MIDI

In order to discover the impact of MIDI, the first step is to understand the limits of production processes and technology before MIDI’s inception. The past will be illuminated through interviews with subjects who experienced the revolution first hand. Steve MacLean (1947- present) and Paul Lehrman (1952 -present) are composers who

²⁰ “Samplers and sequencers, are not performing instruments but gizmos that allow any digitally recorded sound to be fed into another device, including a synthesizer” (Chanan, 161).

²¹ Michael Chanan. *Repeated Takes*, 161.

²² *Ibid.*, 161.

²³ *Ibid.*, 161.

worked with electronic instruments before and after the invention. Examining their reactions to the development will demonstrate the magnitude of MIDI's influence.

MacLean is currently a professor in the Electronic Production and Design Department at Berklee College of Music. A composer, engineer, producer, and performer, "he has been evolving with music technology since the early 1980s."²⁴ MacLean gained experience with early versions of automated mixing consoles and digital audio samplers when he worked in a New York City recording studio. Later, he founded his own studio where he engineered and produced hundreds of projects for commercials and soundtracks, including his own compositions. MacLean releases recordings internationally through Recommended Records.²⁵

He recalled that before MIDI, there was a connector called DIN sync that allowed drum machines and other devices to connect a sequencer²⁶. This connector would allow equipment of the same brand to exchange information. However, they would "sync with their own proprietary format" and did not allow for different makes of equipment to interact.²⁷ In the early 1980's, MacLean began to see electronic instruments and sequencers with MIDI ports. He stated that MIDI was invented because customers wondered why they could not connect an Oberheim drum machine to a Yamaha keyboard or a Roland sequencer. The incompatibility among different brands hindered sales and customer satisfaction. At first there was a collective hesitation about the new development. Artists feared that if a user plugged a cable into a MIDI port

²⁴ Steve MacLean. "Steve MacLean." Steve MacLean | Berklee College of Music

²⁵ Ibid.

²⁶ "An electronic device that creates automated repeatable sequences of sound." (Hugh Davies. "Oxford Music Online.")

²⁷ Sarah Lambert and Steve MacLean. "Working with MIDI."

while the devices were turned on, that the equipment would be damaged in some way. After “that was all laid to rest, MIDI really took off as a way to connect various pieces of hardware.”²⁸

Lehrman provided another perspective. He is “one of the world’s leading experts on MIDI and computer music.”²⁹ As a composer, educator, writer, and technologist, Lehrman has been working with electronic music since 1970. He wrote the world’s first all-MIDI album and composed scores for television, film, and multimedia. Lehrman has been teaching college level computer music and audio engineering since 1986. Now, he is the Director of Music Engineering at Tufts University and created the curriculum of the Sound Recording Technology program at the University of Massachusetts Lowell. Lehrman is also the Education Director of The MIDI Association. He authored numerous books, articles, and manuals for music and audio hardware and software. Additionally, he co-developed the first graphic-based MIDI sequencer for Apple, and remains a consultant to over a dozen electronic music companies.³⁰

Lehrman remembers that there were synthesizers in the late 1960’s, but they were very expensive. By the late 1970’s, they were much more widespread “but it was difficult to get synthesizers to work together.”³¹ Artists could compose on one synthesizer, but if they wanted an ensemble of synthesizers or an orchestra of electronic instruments, it was more complicated. Lehrman recalls “it was difficult for the synthesizers to

²⁸ Sarah Lambert and Steve MacLean. “Working with MIDI.”

²⁹ “Paul D. Lehrman, PhD.” Paul D. Lehrman - Musician, Writer, Technologist, Educator, 18 Aug. 2013, paul-lehrman.com/frame.html.

³⁰ “Paul D. Lehrman, PhD.” Paul D. Lehrman - Musician, Writer, Technologist, Educator, 18 Aug. 2013.

³¹ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

communicate with each other or for you to tell multiple synthesizers what to do at the same time.”³² There were a number of manufactures like Roland, Oberheim, and Sequential Circuits that developed ways to solve this problem between their own products, but not a completely universal solution.

For those who were using electronics to compose in the late 1970’s, every parameter on a synthesizer “had to be defined and laboriously programmed via a numerical keypad.”³³ Even though it was a slow process, programmers were able to manipulate electronic sound in various ways. Artists could cut, paste, and copy sections of music, simulate parts that were impossible to play, and change keys, tempi, sounds, notes, or timings even after recording all of the parts.³⁴ However, the process was so intensive that it was not a common technique. Moreover, artists were unable to “control acoustic instruments and vocals” at this time; each audio sample “had to be played and sung live to analog tape, and once recorded, were difficult to alter.”³⁵

Founding of MIDI

In 1981, the electronic instrument manufactures began a dialogue to solve the problem. The California synthesizer maker “Sequential Circuits ... became the first company to propose a common digital interface for synthesizers of different manufacturers.”³⁶ The president, Dave Smith, held meetings with various American and Japanese companies to develop a Universal Synthesizer Interface, or USI. Then they decided to change the acronym to include all musical instruments. Some suggested UMII

³² Sarah Lambert and Paul Lehrman. “Evolution of MIDI.”

³³ Richard James Burgess. *The History of Music Production*. 138.

³⁴ *Ibid.*, 138.

³⁵ *Ibid.*, 138-141.

³⁶ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*.13.

for Universal Musical Instrument Interface, but Dave Smith thought the you-me pun was corny. He said, “Musical Instrument Digital Interface popped in my head,” and when he suggested MIDI, everyone agreed.³⁷

In 1982, the Prophet 600 was connected to another synthesizer of a different brand at the National Association of Music Merchandisers (NAMM). A year later, the *MIDI 1.0 Detailed Specification* was published and MIDI products hit the market from a number of manufacturers: “it quickly became obvious that MIDI was going to become the undisputed industry standard. Soon, just about every serious electronic instrument under development included MIDI capability.”³⁸

MacLean pointed out that “it was very inexpensive for companies to implement MIDI into their devices compared to the gigantic leap in sales that they saw” since consumers were excited that they could suddenly combine instruments together.³⁹ One reason why MIDI was able to achieve universality was because Dave Smith chose not to retain ownership or require a royalty for its use.⁴⁰

There were two other technological developments that arose with MIDI and helped advance MIDI’s popularity. First was frequency modulation synthesis. FM synthesis “was a technology that was developed at Stanford University and was licensed by Yamaha.”⁴¹ It allowed synthesizers to produce realistic orchestral sounds. By the mid-eighties, PC, Apple Macintosh, Atari St, and Commodore Amiga took advantage of the graphical user interface (GUI) and packaged it into software programs. These programs promoted MIDI even more than FM synthesis, “The convergence and integration, or

³⁷ Stephen Fortner, “Dave Smith.” *Keyboard*, vol. 42, no. 9, Sept. 2016, pp. 14–21.

³⁸ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 13.

³⁹ Sarah Lambert and Steve MacLean. “Working with MIDI.”

⁴⁰ Richard James Burgess. *The History of Music Production*. 129-130.

⁴¹ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.”

packaging, of the many tools that producers use into one device (DAW)⁴² had its own further empowering effect on creativity and productivity.”⁴³ Once parameters could be edited from a customizable screen, MIDI was used to accompany these programs.⁴⁴ With the creation of a “self-contained production box,” recordings emerged that were created entirely from a digital domain.⁴⁵

CHAPTER 3: HOW MIDI CHANGED THE COMPOSING PROCESS

MIDI allowed composers to instantly hear their works realized. Electronic music has been around since the 1940’s, but was not capable of recording and simulating traditional instruments until the early 1980’s.⁴⁶ With associated plug-ins and effects devices, artists now had a practical home-studio, making MIDI an essential and monumental achievement. Coupled with DAW and FM synthesis, MIDI allowed artists to produce quality music entirely on their own. It “increased access to a rapidly expanding palette of sounds and began the convergence and integration of the various technologies and methodologies. The many all-in-one units and subsequent software programs, along with falling prices, signaled the beginning of the democratization of the production process.”⁴⁷ MIDI is a transformative technology in that it “is probably one of the greatest success stories in permitting maximal flexibility for creators” simply by establishing a common language for synthesizers, samplers, and sequencers.⁴⁸

⁴² Digital Audio Workstation (The MusicRadar team. “The 20 Best DAW Software Apps in the World Today.”)

⁴³ Richard James Burgess. *The History of Music Production*. 145.

⁴⁴ Richard James Burgess. *The History of Music Production*. 142.

⁴⁵ *Ibid.*, 142.

⁴⁶ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 11.

⁴⁷ *Ibid.*, 11.

⁴⁸ Richard James Burgess. *The History of Music Production*. 130.

Lehrman recounts, “the biggest change with MIDI was that it became possible to have your own orchestra at home.”⁴⁹ Prior to MIDI, if composers wanted to write instrumental music they used paper and pencil. Then, they needed to hire musicians to play it and spend time rehearsing with them before recording it. Making an electronic recording was possible, but it was difficult and expensive to manipulate many oscillators, synthesizers, and other devices to create a desired sound. By the 1970’s, synthesizers were less expensive but still could not work in conjunction with other devices of a different brand.

DAWs such as Logic, Qbase, Seplenar, Protools, Ableton Live, Fruity Loops and others all “use MIDI just as much as they use audio... It’s incredibly handy, and every notation program is going to use it too because it simplifies what you need to do with notation scores, parts, etcetera.”⁵⁰ MacLean saw that once MIDI was released, it became essential for any competitive compositional program to also integrate this system. Therefore, if any composer wanted to use a computerized platform, they were most likely using MIDI.

With the invention disseminating in the early 1980’s, people finally had the opportunity to build their own home studio for a few thousand dollars instead of tens of thousands. Suddenly, a computer became a practical compositional tool with a keyboard or mouse as the input device. With the ability to instantly playback the music, composers were able to receive immediate feedback without the need to hire a musician. As a result, the electronic music composers were more inclined to write music because they could use their own set of equipment to make all types of credible ensemble music. The process

⁴⁹ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.”

⁵⁰ Sarah Lambert and Steve MacLean. “Working with MIDI.”

was made easier, faster, and cheaper. It wasn't long before orchestral composers saw the benefits and they too began to use DAWs with MIDI.

MIDI's use became controversial as it relates to "musica practica." This medieval term is used to describe "the everyday practice of music, as opposed to the theory; music by ear rather than by the book; the practice through which it lives and breathes, and is transmitted from generation to generation, and which every generation modifies according to its own needs."⁵¹ Computer programs encourage composition through audible experimentation rather than analysis, yet they overshadow the actual performance of music and prompt continuous circulation or adaptation of a tune. As a result, some believe that MIDI contradicts the principle, while others see MIDI as a new form of musica practica "arising out of microchips and cables."⁵²

Using a sample when electronically composing is to use someone else's prerecorded tune as part of a new work. MIDI samples can be transposed, augmented, or edited in some way as to distinguish it from the original. However, sampling created an authorship problem as songs and works were mixed, altered, and formatted by different people. Moreover, it generates unoriginal material. Yet, sampling makes music production easy, quick, and inexpensive; "musical knowledge is useful but not necessary."⁵³ The idea of easy composition attracts young music lovers who wish to make popular music through samples instead of musical gestures. Without moving from a chair, artists began creating not only a score, but "a digitally constructed audible

⁵¹ Michael Chanan. *Repeated Takes: A Short History of Recording and its Effects on Music*. 13.

⁵² *Ibid.*, 161.

⁵³ *Ibid.*, 163.

work...and for a mass market.”⁵⁴ To those with compositional experience already, like Lehrman, MIDI supplemented the process and helped to maintain their style of music through a number of ways.

Before MIDI, Lehrman was composing for string quartets, wind ensembles, and percussion ensembles. He found the process “really frustrating” because he could spend six months working on a piece only to realize that his music did not sound how he had envisioned when it was heard live.⁵⁵ Lehrman also wondered if the moments of audible weakness were the fault of the musicians, or his composition. He would have to revise his work before rehiring the musicians for a second trial run. Now, composers can write music on a computer, quickly play back an accurate audio sample, and edit easily. Soon, composers of various genres were using MIDI; “it created a whole paradigm for people to compose and produce music on their own, which really wasn’t available before then.”⁵⁶

In 1986, Lehrman created the world’s first all-MIDI album. The technology’s efficiency coupled with Lehrman’s fascination with gadgets resulted in a rapid production of new music; *The Celtic Macintosh* was composed in less than two weeks. He used a sequencing program called Total Music that he helped to develop and a collection of MIDI instruments. Lehrman “enjoyed the process so much.”⁵⁷ He was able to create something that was produced entirely by him; there was no need to hire musicians or recording technicians. His motivation was higher and the production time was reduced.

⁵⁴ Michael Chanan. *Repeated Takes: A Short History of Recording and its Effects on Music*. 161.

⁵⁵ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

⁵⁶ Ibid.

⁵⁷ Ibid.

Composing was not only faster and more enjoyable, but was transformed into an entirely new process with the use of MIDI and DAW programs. Firstly, composers like Lehrman began to listen to their music as they compose. With the ability to playback a section of music quickly, easily, and cheaply, composers feel free to listen to their work as many times as they want. This permits them to spend more time being meticulous and editing their work to their heart's content. Editing itself has become faster and easier with software rather than with bulky equipment and retakes. Compositions often build off of certain patterns or themes as they progress. If the composer has the opportunity to hear their music early on, then their piece of music can evolve from and build off of a preferred beginning.

The new compositional possibilities also change the way artists conceive new music. Since the notes are inputted via keyboard or computer, there are no limits on what notes can be chosen. Any instrument can have any range and play even the fastest sequences with perfect accuracy. This expands the possibilities of what can be achieved musically, and harbors a new kind of inventing. Composers can now write music in a limitless fashion. This new kind of conceptualization allows artists to write music that was impossible to play before electronic orchestration.

Lehrman believes that this method of composing expands the emotional range of the music. If a composer chooses notes that are out of range for a particular instrument, it draws special attention to that line of music. So rather than use these 'impossible' notes and tempos just as often as conceivable music, Lehrman suggests that they serve a separate purpose. For example, if you wanted to expand the range of a violin, you have to think of the reason "you would make something that is better than the violin or different

from a violin; ... it has to be a conscious choice it cannot just be” because the “notes sound pretty cool.”⁵⁸

Using a digital environment to create music offers other opportunities to the composer. When using pencil and paper, the composer can indicate where they wish the dynamics or tempo to change, but they do not have direct control over the quality of the sound. With MIDI and an electronic orchestra, the artists can “act as techno-conductors, having complete control over a wide palette of sounds, their timbre (sound and tonal quality), and overall blend (level, panning, and other real-time controls).”⁵⁹ They can immediately hear their dynamics and pay close attention to their expressive decisions.

Another new option available to the electronic composer is looping. The ability to loop is to “play back a given selection of MIDI data repeatedly.”⁶⁰ This allows the composer to hear an exact replica of their recorded music as many times as they desire. With live instrumentalists, repeated takes are never identical, making it more difficult for the composer to isolate any undesirable characteristics. Looping gives the composer many chances to examine a section of music without needing to rewind.

Therefore, MIDI has permanently altered the modern composition process. It became evident that “...the digital language is an important medium that lets artists express themselves with a degree of flexibility and control that was, before its inception, not possible on an individual level.”⁶¹ MIDI allows musicians to “develop a song or

⁵⁸ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

⁵⁹ David Miles Huber, *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. 2.

⁶⁰ Paul D. Lehrman and Tim Tully. *MIDI for the Professional*. 81.

⁶¹ David Miles Huber, *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. 2.

composition in a practical, flexible, affordable, and fun production environment.”⁶² Not only is MIDI used for recording and composing, but also during live performances.

Electronic musician, Holly Herndon (1980- present), uses MIDI in live performance and in composition. Using buttons, knobs, and sliding faders, she maps out sounds on her computer.⁶³ She believes that this is the revolutionized way to approach composition, “Maybe this kind of Western piano interface isn’t the best way to write music, and that’s what’s so interesting about MIDI. Maybe the best way to compose a new piece is to turn a knob in a certain way or to use faders.”⁶⁴ The controversy exists between the traditional and the contemporary, and this tension is no different in relation to the MIDI recording process.

CHAPTER 4: HOW MIDI CHANGED THE RECORDING PROCESS

The recording process involves extensive editing and equipment to produce a finished project, but MIDI reduces editing time and eliminates the need for equipment. Since MIDI is an easily implemented communications protocol, “it is also an excellent tool for automating many functions in the music studio.”⁶⁵ Before MIDI, mixers adjusted effects with front-panel controls or remote controllers in a studio. Console automation systems were expensive, but today MIDI is used to perform any studio function. The fact that this development allows data messages to be transmitted through one network “makes it possible for electronic musicians to record, overdub, mix, and playback their

⁶² David Miles Huber, *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. 2.

⁶³ Louis Pattinson, “An Interview with Holly Herndon.” *FACT Magazine: Music News, New Music*, 26 Nov. 2016, www.factmag.com/2015/05/30/holly-herndon-interview/.

⁶⁴ Sami Yenigun, “The MIDI Revolution: Synthesizing Music For The Masses.”

⁶⁵ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 149.

performances in a single working environment...”⁶⁶ Recording with MIDI also opens up new opportunities for an artist that alters the quality of their final product.

Instead of recording all instrumentalists at the same time, MIDI composition often happens in layers by the same musician or the composer. Sometimes one person spends time recording each instrument and then adding each recording to the composition one at a time. By perfecting each part individually, no one has to worry about individual instrumentalist errors that are likely in an ensemble recording. This means there is also no need to gather musicians in the same place at the same time. Looping can also aid the recording process. It can create a new track with each loop, permitting musicians to quickly record multiple takes in a short section of the piece rather than asking an orchestra to play an entire movement over again.⁶⁷

Even when a MIDI recording is full of mistakes, the data can be edited and altered to perfect a performance. MacLean recognizes that “once you record audio, you’re locked in to that quite a bit,” but “if you record with MIDI, you’re never locked in; you can always change the timing, the sound, the dynamics...up until the last possible moment.”⁶⁸ With the shift toward computerized editing of vital musical decisions, came a social change. Once belonging to the composer, “musical power is now in the hands of the technologically aware, of the producer, sound engineer, mixer and remixer.”⁶⁹ As a result, composers can decide to relinquish control over their music, or become a recording artist themselves. Now, many more composers are also skilled mixers compared to before the introduction of MIDI. The resulting recordings may not be

⁶⁶ Ibid., 149.

⁶⁷ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 82.

⁶⁸ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

⁶⁹ Michael Chanan, *Repeated Takes: A Short History of Recording and its Effects on Music*. 161.

mastered and mixed to perfection, but composers are able to release their music cheaper and faster with more personal management than before.

A situation where MIDI is particularly useful is when music needs to be synchronized to film. Without the ability to move notes and audio segments in time, it would be difficult to match moments on screen with movements in a composition. With MIDI, a sound effect or the climax of a piece can happen at a specific moment. Users can zero in and micromanage the coordination between music and motion picture down to the frame. This takes the pressure off of conductors during the recording process, leaving the work of matching the music to the video in the hands of the editor. In this instance, MIDI is dividing roles between different professionals to realize a work. However, it should be noted that in the case of the amateur artist who uses MIDI in a home studio, the roles of editor and musician are combined.

Another aspect of recording involves varying the performance and control parameters of a musician's take. Some of these adjustable elements available to the electronic composer are quantization, randomizing, and effects processing. Quantization is a setting that alters a MIDI recording to sound metrically perfect. This can be a useful feature to correct the rhythmic inaccuracy of a performance. However, the human ear tends to prefer "the rhythmic nuance imparted by a human player to absolute, computerized precision."⁷⁰ Some sequencers allow the user to adjust the sensitivity or amount of quantization to avoid a completely robotic sound.

Randomizing is a feature that is essentially the opposite of quantizing. The computer will randomly pull notes "away from the beat, forward or backward, by an

⁷⁰ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 82.

amount whose limit is specified by the user in ticks or percentages.”⁷¹ Music that is quantized can be made to sound more natural with randomization. However, skilled musicians do not actually have random metrical mistakes. Although not rhythmically perfect, musicians have a certain pattern to their performance that adds up to their artistic expression. Therefore, randomizing is a useful tool to make edited MIDI notes sound more natural, but it still cannot perfectly simulate a human performance.

Some of the effects processing used to manipulate recordings are reverbs, delays, equalizers, and compressors. Usually manipulated by controllers, the “effects processors are an important MIDI tool in recording and post-production, as in live performance.”⁷² Reverb, or reverberation, creates an echo effect algorithmically. Delay has a similar effect, playing a signal again shortly after the initial signal to essentially prolong the decaying note. This can be used to mimic the sonic qualities of different recording spaces. Equalization, or EQ, “is the cutting or boosting of a particular frequency (or range of frequencies) in the frequency spectrum.”⁷³ It is used to alter the tone of the music and to create a balance between the different frequencies of multiple parts. Compression restricts the range in dynamics of an audio signal, making the louder parts of the recording sound quieter while increasing the volume of the softer sections.

Sound files or segments can also be altered using DSP, or digital signal processing. These options also modify the music according to algorithms and permit the user to undo any undesirable changes, or save the results. One of the most common changes is adjusting the amplitude with processes such as gain changing, normalization,

⁷¹ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 83.

⁷² *Ibid.*, 149.

⁷³ Leticia Trandafir, “Audio Effects: The Beginner's Guide to Shaping Your Sound.” *Audio Effects: The Beginner's Guide to Shaping Your Sound*, LANDR, 29 Sept. 2017, blog.landr.com/audio-effects-plugins-guide/.

and fading. Gain changing modifies the amplitude proportional to a certain level, whereas normalization makes changes on a scale up to 100%. These functions help mixers balance the volume of the tracks on a more specified level rather than simply fading the amplitude.

Fading “is accomplished by increasing or reducing a signal’s relative amplitude over a defined duration.”⁷⁴ A crossfade helps smooth a transition between two pieces of audio that sonically clash or are at different amplitude levels. The ability to shift pitches and rhythm of an audio recording is also a kind of digital signal processing. All of these effects offer huge benefits to the recording. Instead of meticulously arranging microphones or performing numerous recordings to avoid instrumental error, electronic editing can correct and enhance a performance. It can be used in a way to innovate acoustically impossible sounds for a new style of music.

With all of these new components made available to the composer, artists began introducing new sounds and conventions to music. MacLean released an album in 2008 entitled *Frog Bug Guitar Computer* that blends the sounds of nature into rhythmic music using a computer. Each track contains “field recordings of frogs and insects, improvisations on acoustic guitar, and digital treatments of the aforementioned.”⁷⁵ MacLean captured bugs, brought them into a studio, and transposed their sound down a couple octaves so he could examine “what they’re really doing on a human level.”⁷⁶ He

⁷⁴ David Miles Huber, *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. 139.

⁷⁵ François Couture, “Frog Bug Guitar Computer - Steve MacLean | Songs, Reviews, Credits.” AllMusic, All Music, www.allmusic.com/album/frog-bug-guitar-computer-mw0000790936.

⁷⁶ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

would then convert those original recordings into MIDI files in order to compose pieces with the ability to manipulate and edit the audio.

Without MIDI, this innovative album could not have been created. It gave MacLean more control over the sound with new ways to manipulate the pitch and rhythm. If all he had to work with were audio files, he could not have created a cohesive piece of music. Bugs and frogs would sound more noisy than musical unless they offered rhythmic downbeats and a certain harmony, but “by the third song on that CD you’re hearing a drum solo made entirely out of bug rhythms.”⁷⁷ MacLean used the computer to change the timing and pitches of some of the notes in order to achieve a practical arrangement. The concept of composing with natural sounds would not have been an option if not for MIDI’s impact on recording. Having greater control over the editing process permits any kind of audio recording to be eligible for musical use.

The album’s inventive soundscape was also made possible by layering different recordings on top of one another. In 2007, MacLean recorded frogs along the California coast in late May, and bugs of Long island in late August. The guitar recordings occurred at both locations.⁷⁸ Without the ability to mix different recordings at separate times, *Frog Bug Guitar Computer* would not have been possible. Even if MacLean managed to gather these different creatures in one location, he would not have been able to control when they vocalize or how the sounds interact. The idea for this album stemmed from MacLean’s curiosity with MIDI’s features and this idea that the composer suddenly had more control over the recording. With that control comes more settings to wield, and therefore expands the artistic palate.

⁷⁷ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

⁷⁸ François Couture, “Frog Bug Guitar Computer - Steve MacLean | Songs, Reviews, Credits.”

If artists do not want to use a conventional DAW program to compose, they can build their own. MAX is software for audio, MIDI, and video, wherein each element can be combined to build new applications or programs. From there, “you save them and they become a stand alone program that you could then sell.”⁷⁹ The MIDI protocol can be repackaged and tailored to individuals for optimal use, spreading its pervasiveness and capability. These new opportunities give the composer the ability to make a more precise recording that better matches their artistic vision. If more variables translate into a work that is closer to the composer’s ideal, it can be argued that the music benefits from MIDI.

In the modern music industry, it is impossible to ignore. Some composers feel compelled to make use of this technology when recording in order to stay competitive. There is a fear that if artists do not take advantage of available innovations, then their music may not be living up to its full potential and may suffer. As in composition, musicians and music scholars disagree over whether the musical outcome benefits from MIDI’s adoption. Regardless, there is no going back. Whether composers choose to embrace technology or not, it will always be prevalent in the recording process.

CONCLUSION

MIDI “has changed the way we produce music more than any other single technology since magnetic tape.”⁸⁰ Suddenly composers began working at home with a computer. They started producing music faster than before and did not need an orchestra to create a demo recording. When Smith “released the general MIDI 1.0 specification to the world free of royalties for all to use in 1982,” he gave companies permission to

⁷⁹ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

⁸⁰ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 9.

develop and expand its use for over three decades.⁸¹ Many steps were eliminated from the music production process, including elements of composing and recording.

Commercially as well, “the development of MIDI as an industry standard communications protocol for the control of synthesizers fundamentally changed the working environment.”⁸² MIDI “has revolutionized the way people work in every aspect of music and sound production from the bedroom studio to the multimillion-dollar production suite.”⁸³

MIDI provides benefits at various stages of the music production process. Composers and arrangers who want more than traditional techniques and instruments use MIDI. It is also a useful tool for the post-production editor who wants better control over their sound. It facilitates the recording and mixing process for audio engineers, and makes it easy to quickly synchronize music to film. Educators use MIDI when demonstrating composition, arranging, theory, acoustics, or music and technology to students. Finally, MIDI simplifies the music production process for aspiring musicians. It gives anyone the opportunity to have a home studio where quality music can be produced without hiring recording technicians or musicians. With an easier and less expensive process, MIDI reduces the barrier that prevents people from becoming a composer, and paves the way for future music artists.

In order to dictate exactly how MIDI changed the composing and recording process, this conclusion reviews the impact it has on its users and presents whether these affects are positive or negative. First, MIDI music will be examined from the standpoint of a recording engineer. One negative affect that MIDI has on recording is how it limits

⁸¹ Richard James Burgess, *The History of Music Production*. 141.

⁸² Peter Manning, *Electronic and Computer Music*. 263.

⁸³ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 9.

human interaction. At the 2017 Audio Engineering Society conference in New York, Emily Lazar (1970-present), chief mastering engineer at her recording studio, spoke about the growing lack of collaboration in music production.⁸⁴ Lehrman agrees, “There’s a synergy that happens when musicians work together;” they listen to and interact with one another. Live orchestras generate a whole that is greater than the sum of its parts, and this affect is taken away by recording instruments one at a time with MIDI.

Some of the MIDI editing tools for mixers have negative aspects. When looping is used to repeat a phrase, the recording replays an exact duplicate of the audio. Although this allows the recording artist to hear a perfect reproduction of what was performed in the first segment, they miss out on desirable nuances in each repetition that are only possible with multiple live performances. Quantization is useful when someone wants perfect renditions of various rhythmic patterns. However, it can hurt the quality of the recording; “while this feature has allowed more people with less technique to record more music, it has also been responsible for the production of a lot of rhythmically stiff, and ultimately boring, music.”⁸⁵ Although, some new genres such as techno-pop music have successfully popularized the quantized or computerized rhythm. The randomizing feature is a useful tool to make edited MIDI notes sound more natural, but again, it cannot sound completely organic.

Despite these drawbacks, MIDI gave audio engineers the opportunity to record new kinds of music that would not have been possible before this new technology. For example, Lehrman was given an opportunity to work on “The Ballet Mécanique.” This piece of music was written in 1924 by George Antheil (1900-1959) and requires 16

⁸⁴ “AES New York 2017 Presenter or Author.” AES New York 2017 » Presenters: Emily Lazar, Audio Engineering Society, 2017, www.aes.org/events/143/presenters/?ID=6264.

⁸⁵ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional*. 82.

synchronized pianos, among many other instruments.⁸⁶ The futuristic composition could not be realized within the composer's lifetime. The piece contains many time signature changes, and pianists found it too difficult to stay in tempo with each other. It was not until 1999 that the piece was actually performed in its full orchestration; "by hooking up sixteen MIDI-compatible player pianos to a central sequencer via an ordinary desktop or laptop computer, you can get them all to play in perfect synchronization."⁸⁷ Lehrman took all 1,240 measures of Antheil's original score and translated it into one MIDI file that could be played on a sequencer. In the performance, the conductor listened to a metronome through an earpiece that was in time with the pianos. Thanks to MIDI, "The Ballet Mécanique" has now been performed dozens of times in famous venues across the globe.

From the composer's side, MIDI can have a detrimental effect on the music produced. Lehrman wrote an article entitled "Why MIDI Music Stinks" to caution readers against using technology frivolously. He believes that composers are lazier now because they don't have to work as hard to produce music. They rely too much on the computer, and as a result, "a lot of music came out sounding very much the same."⁸⁸ For example, the most common tempo for dance music today is 120 beats per minute because "that's the default setting for almost any sequencer on the market."⁸⁹ Many people are working with electronic production tools without practicing or exploring the depth of the technology. Since it does not take as much background knowledge to create music, many amateurs unintentionally write impossible notes or intervals without knowing the limits

⁸⁶ Paul D. Lehrman. "The Ballet Mécanique Page." The Ballet Mecanique Page, Paul D Lehrman , 28 Oct. 2009, antheil.org/.

⁸⁷ Ibid.

⁸⁸ Sarah Lambert and Paul Lehrman. "Evolution of MIDI." 22 Oct. 2017.

⁸⁹ Ibid.

of each instrument. Lehrman teaches his students “if you want to make a realistic sounding electronic instrument you have to know what the instrument really sounds like.”⁹⁰

Critics believe composing with DAWs has a negative influence on music production due to Auto-Tune and over editing. When composers have access to countless parameters, they feel that they have to manipulate them all in order to use DAWs like Pro Tools and Logic Pro to their full potential. However, sometimes the best music is less refined, “if the desire is to represent a performance as it happened, a DAW can do that; the human operators need only exercise restraint.”⁹¹

Even though there are some disadvantages, the digital audio workstation revolutionized music production by giving artists the power to easily manipulate and optimize their music. MacLean believes there are no downsides to MIDI. It changed the way that composers conceive music by opening up new sonic opportunities. It is also cost effective. MIDI keyboards alone integrate many built –in features to a make a portable, complete music production system. Additional MIDI instruments can be added to the workstation; “MIDI production systems can appear in any number of shapes and sizes and can be designed to match a wide range of production and budget needs.”⁹² Aspiring artists no longer needed to study music or spend a great deal of money to compose, and they found that “the convergence and integration, or packaging, of the many tools that

⁹⁰ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

⁹¹ Richard James Burgess, *The History of Music Production*. 134.

⁹² David Miles Huber, *The MIDI Manual: A Practical Guide to MIDI in the Project Studio*. 5.

producers use into one device (DAW), had its own further empowering effect on creativity and productivity.”⁹³

The future development of MIDI is already underway. MIDI data can be transmitted through Ethernet or wirelessly over Bluetooth. There is multi-channel polyphonic expression, which allows the mixer to adjust certain special parameters like pitch bending on different notes independently. New instruments have been invented as well, like the Roli Seaboard. This form of keyboard is made of rubber and can change various aspects of its sound based on how and where the musician touches the instrument. It allows people to play vibrato on keys the way they could on a violin, and each note can respond individually. Lehrman agrees, “MIDI has possibilities for expansion,” and will become even more expressive and ubiquitous.⁹⁴

MIDI continues to be integrated into all areas of music production and performance. MacLean said, “I have a device that I invented where you can strap a little Velcro strip around my throat and just hum into a transducer and convert those signals into MIDI messages.”⁹⁵ This means a computer can create data messages such as note on or note off, pitch, and velocity directly from live vocals. With this device, MacLean can edit vocals just as easily as he can manipulate melodic sequences from a MIDI keyboard. In fact, it is possible to extract a MIDI file from an audio recording, “which means at that point the sky’s the limit” in terms of editing.⁹⁶

MIDI has changed the way music is made. The lives of composers and recording engineers were radically altered in the early 1980’s. MIDI is a “transformative

⁹³ Richard James Burgess, *The History of Music Production*. 145.

⁹⁴ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

⁹⁵ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

⁹⁶ Sarah Lambert and Steve MacLean. “Working with MIDI.” 20 Oct. 2017.

technology, in that different makes of synthesizers, samplers, and sequencing devices can now talk to each other in a common language.”⁹⁷ This was a major step in commercializing music making. Before then, the production process was reserved for the professionals in the music industry. MIDI developed and expanded composition and recording in a variety of ways. Not only has the production process changed, but also the music itself has a different quality. Music that was previously unimaginable is now possible. MacLean and Lehrman were able to release solo piano pieces that no human could play. Additionally, MacLean’s *Frog Bug Guitar Computer* album and Lehrman’s contribution to the Ballet Mécanique are also testaments to MIDI’s ability and power to bring unplayable music to life. MIDI is also used in live performances, like in Pat Metheny’s (1954-present) touring ‘robot’ orchestra. MIDI is no longer just a standard communication language, but it is also a standard feature in the modern music production toolkit.⁹⁸ Lehrman believes that “it’s a wonderful language for communication for getting musical devices to talk to each other and it has been built-in, developed, and expanded. It’s definitely going to be part of the musical soundscape for a long time.”⁹⁹ MIDI is an innovation that changed the way composers, songwriters, musicians, and audio engineers invent, generating new kinds of music for the future.

⁹⁷ Richard James Burgess, *The History of Music Production*. 141.

⁹⁸ Powered by Cyclone Enterprise: A Cyclone Interactive Multimedia Group, Inc. e-Solution Set. “BIO.” Pat Metheny : Bio, www.patmetheny.com/bio/.

⁹⁹ Sarah Lambert and Paul Lehrman. “Evolution of MIDI.” 22 Oct. 2017.

Bibliography

Articles

Burnand, David Burnand. "MIDI." *The New Grove Dictionary of Music and Musicians*. Ed. Stanley Sadie. Vol. 16. N.p.: Oxford UP, 2001. N. pag. Print.

This Dictionary article describes what MIDI is and how it functions. It mentions the date the standard was established but does not extensively describe its origin. The Dictionary's site offers links to related terms for further research.

Davies, Hugh. "Sequencer (Fr. Séquenceur; Ger. Sequencer; It. Sequencer)." *Sequencer | Grove Music*, Oxford University Press, 5 Dec. 2017, www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000047622.

The article describes what a sequencer is and what it does. It also describes who invented the sequencer and when it was released into the market. Davies explains how it works technically, and how it can manipulate audio. Additionally, it briefly describes how sequencers have developed over time.

Fortner, Stephen. "Dave Smith." *Keyboard*, vol. 42, no. 9, Sept. 2016, pp. 14–21. ProQuest, search-proquest-com.proxy.bc.edu/docview/1829427044/fulltext/B55E4A4E5F074356PQ/1?accountid=9673.

This article contains an interview with Dave Smith, an inventor who founded the MIDI standard. Smith briefly describes his work involved with MIDI and how the name was founded. However, most of the interview is specific to Smith's business and the different models of synthesizers he created.

Garrigus, Scott R. "Modern MIDI Sequencing." *Electronic Musician*, Feb. 2000, p. 122. Academic OneFile, proxy.bc.edu/login?url=http://go.galegroup.com/ps/i.do?p=AONE&sw=w&u=milm_bostcoll&v=2.1&id=GALE%7CA60069281&it=r&asid=52597d6c66b18788a96511c38c90ce2e. Accessed 29 Oct. 2017.

This article describes a MIDI-sequencing setup and function. Then it goes into detail about quantizing, real-time processing, and virtual routing. It includes pictures of a computer screen to show what MIDI editing looks like.

Lehrman, Paul D. "Fauxharmonic Orchestra | The Ultimate One-Man Band." *EMusician*, ProQuest, 1 Nov. 2009, www.emusician.com/gear/fauxharmonic-orchestra-the-ultimate-one-man-band.

This article is a concert report as well as an informative piece about the progress of live synthesized sound. The conductor, Paul Henry Smith, used Nintendo gaming controllers to manipulate MIDI messages in real time. An electronic orchestra of computers responded to his movements in a completely electronic live performance.

Lehrman, Paul D. "Tomorrow's Musicians and What They'll Be Playing." *Sound on Sound*, Jan. 2006, www.soundonsound.com/people/tomorrows-musicians-what-theyll-be-playing.

This is an article written by Paul Lehrman about the future of music production. It describes some of the new instruments at the New Interfaces for Musical Expression (NIME) conference and what may be in store for future musicians on a technical level.

Mumma, Gordon, et al. "Recording." *The New Grove Dictionary of Jazz*, 2nd ed. Ed. Barry Kernfeld. *Grove Music Online*. Oxford Music Online. Oxford University Press. Web. 28 Sep. 2017.<<http://www.oxfordmusiconline.com.proxy.bc.edu/subscriber/article/grove/music/J371600>>.

This lengthy entry is an extremely detailed description regarding the recording industry and its birth. It is especially helpful for researching technological developments or the history of jazz recording. There is a bibliography of sources at the end of the entry.

Pattinson, Louis. "An Interview with Holly Herndon." *FACT Magazine: Music News*, *New Music*, 26 Nov. 2016, www.factmag.com/2015/05/30/holly-herndon-interview/.

This is an interview with the electronic music artist Holly Herndon. The page also includes a music video of one of her works. It begins with a short biography, and then proceeds with the interview, putting the questions in bold above her answers. The article is easy to navigate, but the page is long with different interviews continuing after hers.

Books

Austin, Michael. *Music Video Games: Performance, Politics, and Play*. N.p.: Bloomsbury Academic, 2016. Print.

The author divides his chapters into categories that vary in scope. There are specific analytics on musical elements in specific video games as well as broader topics like music on YouTube. The book focuses on what makes for successful music in the digital world. With eclectic organization, this text uses the broad title of 'videogame music' to analyze titles from Michael Jackson's "Beat it" to Beethoven's symphonies.

Burgess, Richard James. *The History of Music Production*. N.p.: Oxford UP, 2014. Print.

This source describes the evolution of western popular music genres chronologically. It also lists the various mediums through which producers and consumers interact with audio. The book concludes with a bibliography and an index where MIDI is listed in

multiple places throughout the text.

Chanan, Michael. *Repeated Takes: A Short History of Recording and its Effects on Music*. Verso, 1995.

This book contains the history of music recording from cylinder to disc as well as the public's reaction to these developments. It includes ample information on radio, the record, and mixing. The chapter briefly mentions MIDI and its effects on music. There are footnotes throughout the book with corresponding information in the back along with an index of terms.

Coleman, Mark. *Playback: From the Victrola to MP3, 100 Years of Music, Machines, and Money*. Da Capo Press, 2003.

The book informs the reader on the social history of music development, with topics such as the rise of dance. The book focuses on the record and how radio took over its existence. However, the book does mention various other inventions related to music's development such as the iPod and MP3s. The book is divided into small sections, and includes a bibliography as well as an index.

Collins, Karen, ed. *From Pac-Man to Pop Music Interactive Audio in Games and New Media*. N.p.: Ashgate, 2008. Print.

This book has information about the linkage between music and popular culture. She analyzes how music has taken over our modern existence through mediums such as MTV and ringtones. Gearing toward videogames, this book explains the importance of music and what uses it has in our everyday lives. One chapter explores the hypothetical situation of playing a videogame without sound effects or audio and explains just how different this makes the world of the game. This focuses on the importance of music.

Collins, Karen. *Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design*. N.p.: MIT, 2008. Print.

This book focuses specifically on the genre of videogame music. The author takes the reader through the birth of the videogame and the inception of music for games. She also goes through the process of audio production from start to finish. With a chapter on the 'Synergy in Game Audio,' she also describes the impact music has on games and how games effected popular music. The author concludes with the functions of game audio and approaches to composing for videogames.

Donnelly, K. J., William Gibbons, and Neil William Lerner. *Music in Video Games: Studying Play*. N.p.: Routledge, 2014. Print.

This book uses different video games as a case study for the types of music in videogames and their affect on the player. Specific companies, games, and even musical passages are depicted and analyzed in this book. Well organized and specific, he explains why different sounds have different types of effects on the psyche. The author also

encompasses different genres of videogames from *Super Mario Bros.* to Psychological Horror Games.

Gelatt, Roland. *The Fabulous Phonograph: From Tin Foil to High Fidelity.* N.p.: J.B. Lippincott, 1955. Print.

This is an older book written like a novel. It separates its content into readable chapters and organizes the information chronologically through history. The book contains some helpful illustrations and pictures of machinery and their inventors.

Hitchcock, H. Wiley. *The Phonograph and Our Musical Life: Proceedings of a Centennial Conference, 7-10 December, 1977.* N.p.: Institute for Studies in American Music, Dept. of Music, School of Performing Arts, Brooklyn College of the City U of New York, 1980. Print.

This book is dedicated to people's reaction to the phonograph. Its chapters are divided into reaction from the audience, the composer, the performer, the scholar and critic, and the phonograph and other media. It examines how the phonograph relates to and changed the lives of these groups of people.

Huber, David Miles. *The MIDI Manual: A Practical Guide to MIDI in the Project Studio.* N.p.: Focal, 1999. Print.

This manual contains a brief history of MIDI and descriptions of where it is used. The rest of the chapters are directed toward a technical audience who is interested in setting up equipment and utilizing the interface for audio production. Many pictures and diagrams are included to indicate the setup of synthesizers, cables, and other gear.

Lehrman, Paul D., and Tim Tully. *MIDI for the Professional.* N.p.: Amsco Publications, 1993. Print.

This is “the essential reference for the serious MIDI user.”¹⁰⁰ The introduction includes a brief history of electronic music, the goals of MIDI, and how MIDI works. The following chapters describe necessary equipment and how MIDI relates to the composer, performer, educator, and sound editor. There are also chapters on MIDI's limitations as well as its possible evolution into the future. This guide includes pictures of MIDI editing screens for the user to visualize the technical concepts. Complete with an index, this book is a useful tool for MIDI users and researchers.

Linehan, Andy, ed. *Aural History: Essays on Recorded Sound.* N.p.: British Library, National Sound Archive, 2001. Print.

This book compiles nine essays regarding sound into a single printed work. Each essay has its own author and bibliography. There is an accompanying CD containing music described in the text. However, the essays collected have little in common. For example,

¹⁰⁰ Paul D. Lehrman, and Tim Tully. *MIDI for the Professional.* 1.

one examines the sounds of nature while another analyzes black British swing music between the 1930's and 1940's.

Manning, Peter. *Electronic and Computer Music*. N.p.: Oxford UP, 2004. Print.

This text examines the evolution of electronic and computer music from 1945 to the digital revolution of 1980. One of the chapters revolves around MIDI, its development, and what it may achieve in the future. The book includes notes, a discography, and an index.

Read, Oliver, and Walter L. Welch. *From Tin Foil to Stereo: Evolution of the Phonograph*. N.p.: Howard W. Sams, 1959. Print.

This is an older publication but nevertheless contains a wealth of information. Its contents are divided into short, readable chapters ideal for the researcher to hone in on exactly what they are looking for. Topics include types of phonographs and how the machine evolved over its period of use.

Sampsel, Laurie J. *Music Research: A Handbook*. 2nd ed. N.p.: Oxford UP, 2013. Print.

This handbook is a useful tool for those researching music. It includes many text recommendations with descriptions of each work. With an index and a glossary, this book is easy to use and navigate. There is a brief reference to MIDI and what it may be able to achieve in the future.

Symes, Colin. *Setting the Record Straight: A Material History of Classical Recording*. N.p.: Wesleyan UP, 2004. Print.

This book contains pictures and nine chapters on music making. However, its eclectic content hinders its potential usefulness. With chapters ranging from record covers to the domestication of the concert hall, there lacks a tight cohesive tie to the information at hand.

Interviews

Lambert, Sarah, and Paul Lehrman. "Evolution of MIDI." 22 Oct. 2017.

This is a transcribed interview from a recording. The interview lasted roughly 30 minutes in length. Paul Lehrman is an author, composer, educator, and a technologist who encounters MIDI in every aspect of his career.

Lambert, Sarah, and Steve MacLean. "Working with MIDI." 20 Oct. 2017.

This is a transcribed interview from a 20 minute long recording. Steve MacLean is a "an assistant professor in the Electronic Production and Design Department at Berklee

College of Music” and “a guitarist, composer, producer, and engineer...”¹⁰¹ He has been working with music and technology since the early 1980’s.

Radio Broadcasts

Bateman, Tom. “How MIDI Changed the World of Music.” BBC News, BBC, 28 Nov. 2012, www.bbc.com/news/technology-20425376.

This article includes an interview with Dave Smith, the creator of MIDI. He explains the benefits of the technology and how it was founded. There is a video on the webpage that shows how people are utilizing MIDI. The article is concise, but informative.

Brown, Simon Leo. “Note on, Note off: How MIDI Changed Music.” ABC Melbourne - Australian Broadcasting Corporation, 5 Nov. 2013, www.abc.net.au/local/audio/2013/11/06/3885338.htm.

This recording of a radio broadcast describes how broad MIDI’s usage is. It briefly describes how MIDI works and explains its rapid growth. It includes an interview with Dave Smith, the founder of MIDI. This source also gives insight from foreign musicians and engineers who work with the technology. The artists Severed Heads and Nicole Skeltys speak about how useful MIDI is in the music industry.

Yenigun, Sami. “The MIDI Revolution: Synthesizing Music For The Masses.” NPR, NPR, 12 May 2013, www.npr.org/sections/therecord/2013/05/12/182874125/the-midi-revolution-synthesizing-music-for-the-masses.

This article explains MIDI in a simple, nontechnical manner. It briefly states how it was created and what some of its uses are. There is a video and audio file on the webpage that give audible examples of how MIDI functions. This article contains useful quotes from the founders of MIDI.

Websites

“ABOUT DSI.” Dave Smith Instruments, Dave Smith Instruments LLC, 2017, www.davesmithinstruments.com/about/.

This is Dave Smith’s website that contains information on Dave Smith and the history of his products. It is mostly used to sell his keyboards and synthesizers, but does contain information about MIDI products.

“AES New York 2017 Presenter or Author.” AES New York 2017 » Presenters: Emily Lazar, Audio Engineering Society, 2017, www.aes.org/events/143/presenters/?ID=6264.

¹⁰¹ MacLean, Steve. “Steve MacLean.” Steve MacLean | Berklee College of Music

This website is dedicated to the 2017 Audio Engineering Society conference in New York. It lists the presenters and program with in depth descriptions of events. This page has a lengthy biography of Emily Lazar, one of the presenters at the conference. It includes a link to her personal website, as well as a link to a description of her program. She spoke about how to focus one's mind as a mixer in a world of endless editing possibilities.

Couture, François. "Frog Bug Guitar Computer - Steve MacLean | Songs, Reviews, Credits." AllMusic, All Music, www.allmusic.com/album/frog-bug-guitar-computer-mw0000790936.

This website provides audio excerpts from Steve MacLean's album *Frog Bug Guitar Computer*. It describes a brief overview of the music and includes user ratings and credits for the album.

Hass, Jeffery. "Introduction to Computer Music: Volume One." Chapter Three: How MIDI Works, Indiana University , www.indiana.edu/~emusic/etext/MIDI/chapter3_MIDI.shtml.

This website provides an overview of MIDI and explains how the system works. It contains simplified information describing which elements of sound can be manipulated through MIDI messages. There are 14 pages of information including charts and links to diagrams. The final page lists references and links.

Lehrman, Paul D. "The Ballet Mécanique Page." The Ballet Mecanique Page, Paul D Lehrman , 28 Oct. 2009, antheil.org/.

This page describes "The Ballet Mécanique" and its performance history. It contains links to information about the documentary: *Bad Boy Made Good*, the Lowell CD, and the robots. It answers frequently asked questions about Paul Lehrman's involvement with the project.

MacLean, Steve. "Steve MacLean." Steve MacLean | Berklee College of Music, www.berklee.edu/people/steve-maclean.

This is Steve MacLean's page on Berklee College of Music's website. It contains a quote from MacLean about his work as well as a brief biography. It lists the courses he has taught at the college and provides his contact information.

"Molded Cable, Midi DIN 8 Male / Male, 10.0 Ft - DK238MM-10." L-Com Global Connectivity, L-Com Inc., www.l-com.com/firewire-din-scsi-sata-molded-cable-mini-din-8-male-male-100-ft.

The website contains a useful picture of a MIDI DIN cable connection. It lists the separate pins and what their particular functions are. The picture includes the male and female end of the connector. There are other pictures as well of new types of MIDI cables.

“Paul D. Lehrman, PhD.” Paul D. Lehrman - Musician, Writer, Technologist, Educator, 18 Aug. 2013, paul-lehrman.com/frame.html.

This website contains a lengthy biography of Paul Lehrman. It includes his contact information and links to his music, articles, and books. It also has pictures and includes a link to his “Ballet Mécanique” page.

Powered by Cyclone Enterprise: A Cyclone Interactive Multimedia Group, Inc. e-Solution Set. “BIO.” Pat Metheny : Bio, www.patmetheny.com/bio/.

Pat Metheny’s personal website includes pictures and detailed descriptions of Metheny’s work. The biography page is extensive and accentuates his impressive accomplishments in bold. Other links on the site lead the user to information on his current release, store, contact information, and the news or media articles related to his work.

The MusicRadar team. “The 20 Best DAW Software Apps in the World Today.” *MusicRadar*, MusicRadar The No.1 Website for Musicians, 27 Dec. 2017, www.musicradar.com/tuition/tech/the-20-best-daw-software-apps-in-the-world-today-238905.

The definition and description of DAWs are on this website. The page describes the different options of digital audio workstations that exist on the market today. It is a helpful site to gain insight into the capabilities and functions of specific DAW software programs.

Trandafir, Leticia. “Audio Effects: The Beginner's Guide to Shaping Your Sound.” *Audio Effects: The Beginner's Guide to Shaping Your Sound*, LANDR, 29 Sept. 2017, blog.landr.com/audio-effects-plugins-guide/.

The website has helpful descriptions of audio effects available to manipulate sound. It has a list of links on the right-hand side to scroll directly to individual topics. The definitions and descriptions are detailed, yet easy to understand.