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IMPACT OF MIDI ON ELECTROACOUSTIC ART MUSIC

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IMPACT OF MIDI ON ELECTROACOUSTIC ART MUSIC

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Alex Lane Igoudin
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IMPACT OF MIDI (MUSICAL INSTRUMENT DIGITAL INTERFACE) ON ELECTROACOUSTIC ART MUSIC

Alex Lane Igoudin
Stanford University, 1997

The interaction between art and technology comes to a particularly intense point in the studied case. A new generation of tools leads to extinction of previous media for electroacoustic composition and produces wide-ranging reactions from its users and numerous effects on methodology and artistic results.

Current electroacoustic music scholarship on the subject is summarized, with special attention given to the aesthetic discourse on interaction between the conceptual and technological components of the musical process with electroacoustic media. Evolution of technology for music-making in the 1970s-80s is presented as part of the study's background. Historical development of MIDI and the subsequent spread of MIDI equipment is discussed in the context of the demands of the contemporary electroacoustic art community.

Composer's anticipation, introduction, and reception of MIDI are investigated. The incorporation of MIDI tools and the attempts to transfer pre-MIDI methodology and practices into MIDI-based compositional environments are discussed. Implications of the design of the MIDI protocol as well as the design of MIDI-controlled devices are analyzed and considered in relation to literature on the subject. Social benefits of MIDI equipment are assessed in the historical context.

Particular points that are addressed in the investigation are: changes in musical style that result from interaction with MIDI and MIDI-based equipment; the particular effect MIDI technology has had on the live interactive electroacoustic performance tradition; and changes of compositional approach in the course of transition to MIDI tools. The study also presents an uncommon case of applying certain sociological research methods to a phenomenon in the arts in which a survey was conducted to obtain the necessary research data. All conclusions and analytical observations are based on excerpts from the interviews accumulated throughout the study. Multiple tables referenced throughout the study illustrate the findings of the study.

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Glossary

MIDI	The Musical Instrument Digital Interface
MMA	MIDI Manufacturers Association
IMA	International MIDI Association
CMJ	The Computer Music Journal
ADC	analog-to-digital converter
DAC	digital-to-analog converter
MASC	MIDI/Analog System Control software
ISPW	IRCAM Signal Processing Workstation
HMSL	the Hierarchical Music Specification Language, a programming language for experimental music composition and performance
MUSIC	family of computer languages for algorithmic composition, e.g. MUSIC5
Finale	software notation package manufactured by Coda Music Software, Inc
ProTools	multi-track mixing and editing software manufactured by Digidesign
[]	missing context substituted or paraphrased
[...]	irrelevant information omitted
{}	contextual paraphrase of a word or a phrase in the interview quote
(XXX)	title of a compositional work, or of a custom-made instrument[1]
(38:*B450)	quotation template: the number of the respondent (1-45) on the left is separated by a semi-colon from the lettered tape side (*A, *B, *C) and the tape counter indication for the beginning of the excerpt
*add1	information obtained after the interview by e-mail

[1] Omitted to preserve the privacy of the respondent.

Preface

To avoid any possible confusion about the definition of the studied field, I would like to explain what is meant by the term *electroacoustic art music* throughout the text of this thesis.

'Electroacoustic' points out the difference in the nature of the sound generation. It clearly distinguishes the electrical nature of all devices involved into the composition of this kind of music from the mechanical one present in the traditional acoustical instruments of Western art music. The term first appeared in the 1960s, as *musique èlectro-acoustique* to describe the method of music composition using "amplified devices with acoustic generators" (Cary). Since then it has long superseded the original meaning to cover the entire field.

Since this music is produced for contemplation rather than immediate entertainment and has no direct utilitarian purpose, 'art' describes best this kind of music. This definition is commonly used in literature on the subject (Pope in Editorial, CMJ 15 [3]), (Schrader 1989).

Despite a short period of existence, when compared to other fields of art music, electroacoustic art music has established a tradition of distinct musical techniques, styles and scholarship. One sometimes hears the classification of this field as 'experimental music' but that definition would imply lack of tradition which is certainly true for a lot of art music but not for all. After all, would we classify Beethoven's music as simply experimental? 'Exploratory music' is a similar term used in the literature (Eloy in CMJ 15[1], 16).

The term 'electronic music' has been avoided to describe this area of art music because it is generally understood to describe the music that "consists either wholly or partially of sounds produced by electronic oscillators and modifying devices such as synthesizers and then stored on magnetic tape" (New Harvard).[2] Such definition covers only some of the existing practices in the field. Similarly, I have abstained from using the expression 'computer music' since computer is only one of many devices used in the electroacoustic music. 'Electrophonic music', a term popular in United Kingdom is usually used in reference to tape-oriented music and also insufficient to cover the entire area.

[2] As a term, it was originally coined in German as *Elektronische Musik* at the NRDF studio in Cologne in early 1950s and has often been used to represent that particular electroacoustic tradition.

Chapter 1

Introduction

As the course on the history of electroacoustic music that I was teaching was coming to an end, an interesting problem came up: after spending weeks discussing waves of various technologies that swept over electroacoustic music in more than three quarters of the century, my class and I were faced with a new technological paradigm that took minimal time to be accepted but suddenly changed the way music *sounds*. The change in style was audible, nearly palpable. This music was just as *different* as it was *similar* to the pieces written before. What was it about the creation of this new musical style that made the musical output different? Why would such a powerful change be caused by something outside of music, outside of the intra-art exchange of ideas that has been the engine of the evolution of art music for centuries?

My interest in the subject of interaction between art and technology grew out of that question. MIDI was not the first technological revolution to affect art. However, few such revolutions brought change to the degree that MIDI did. The effect of Johannes Gutenberg's invention of the printing from movable type on literature and the introduction of sound to the motion picture on film can be cited as comparable examples in other art fields.

The practice of Western art music making has not changed much over the last 300 years. The tools and concepts the composer normally deals with today are virtually the same as in the 18th century: a pen, staff paper, the same set of acoustic instruments for performance, the same performance venues, and the same idea of the performer.

MIDI was not the first technological revolution to have an influence on composition style. Other technical advances have had similar impact: Guido d'Arezzo's invention of the staff notation system laying ground for the written tradition of art music; the introduction of the pianoforte leading to a transformation of the keyboard style at the turn of 19th century, the use of the metronome affecting Beethoven and his successors, the influence of arts other than music in multi-media genres (opera, ballet, film) on music composition methodology, and the birth of recording bringing about new compositional techniques in 1930-40s, known as *musique concrète*. Never before, nor ever since the introduction of MIDI, however, have we witnessed a change in the tools employed by the artists for the creation of art as quick, universal and profound as in the case of the standardization of digital musical instruments and computers in the mid-1980s. MIDI-based music technology provided an entirely new and comprehensive array of composition tools.

The flood of MIDI-based hardware and software appearing within two years after the introduction of the standard transformed the concepts of the contemporary electronic music studio, the digital instrument, and the role the computer plays in musical composition.

The increased presence of electroacoustic works within the general category of art music was in part due to the MIDI phenomenon enticing the interest of non-electroacoustic art music composers as the tools for electroacoustic composition became easily accessible. Increased accessibility of electroacoustic tools was one of two major advantages resulting from the MIDI-based technological revolution. Furthermore, MIDI enhanced possibilities for experimentation with compositional ideas by facilitating compatibility between composition tools.

There is an abundance of literature explaining the technical and engineering aspects of the MIDI protocol in detail, and the reader is referred to, for example, MIDI 1.0: Detailed Specification, Pellman 1994, Rothstein 1995, for a technical description. The present study concentrates on the impact MIDI has had on art music composition, focusing on composers who were active in electroacoustic music before and after the introduction of MIDI as the primary sources. The composers' reception of MIDI has not been previously researched. The influence of MIDI on electroacoustic commercial music is outside the present scope.

My hypothesis at the outset is that

> **The revolution in the tools for music composition in the mid-1980's caused a major change in electroacoustic music composition itself.**

Despite the enormous amount of literature written on MIDI, such a study has been lacking until now. My intent is to move away from the mere description of the events and to generalize the phenomenon, reveal common trends behind a chain of facts.

The constituent parts of Western musical thinking, transformed but nonetheless present in electroacoustic music, are brought to the fore of the current research. I will also look at how MIDI has affected the two poles of electroacoustic music, namely its live interactive and tape traditions.[1]

---

[1] The genres of electroacoustic music fall into a polar relationship determined by the performance media: tape music, understood as pre-recorded tape-based performance, is at one end of the spectrum and live interactive music, in which the changes to the musical output occur during the live interaction between the performer and the electroacoustic devices, is on the other. This distinction is common in the scholarship in the field: "Today two overlapping categories of computer music systems stand out. One is based on live performance, the other on studio technique. Live performance computer music has seen a flurry of development prompted by the availability of inexpensive equipment linked by MIDI" (Music Machine, 63); "Tape music is at one end, where the electronics ignores the performer. At the opposite end of the continuum are systems that drive synthesizers directly from sensors that extract performance parameters" (Loy, 23).

Besides inducing the emergence of a new style in electroacoustic music, the MIDI phenomenon has also highlighted an array of thorny aesthetic and technological issues. Since the technology was not directly designed for the demands of non-commercial art, conflicts arose in the interaction between these two spheres. Thus, the historical development of MIDI, the initial reaction to it, and the evolution of the reception of MIDI in the art music community are treated as aspects of the question.

The recent origin of the studied phenomena has contributed to the particular significance of this study by allowing the accumulation of highly valuable documentary information and the rare chance to communicate directly with the creators of the music. Such features can not be regained after significant time has elapsed from the original developments of the events.

Chapter 2

Design of the Study

2.1 Guarding Objectivity

In essence, the goal is a theoretical study based on descriptive data. The objectivity of the study was a priority of the author. Throughout the course of it the author remained neutral with the respect to the opinion poles, fully accepting or fully rejecting MIDI. The tendency in the questionnaire and in the interviews to persist and linger on analyzing various aspects of MIDI impact when it occurs, may be perceived as imbalanced in comparison to the interviews where such impact did not occur. This tendency is due to the main objective, which is the assessment of the influence MIDI and MIDI-based equipment on electroacoustic music, its counterpart, namely, the lack of change, is ineloquent by its nature.

There were five stages of the study:

1. Selection of a problem, later developed into the hypothesis of the study; design of the research methodology;
2. Bibliographical research setting the historical, sociological and aesthetic context for the study;
3. Data collection;
4. Data classification;
5. Data analysis and interpretation.

2.2 Available Sources

Collected sources are presented in a bibliography following the text of the dissertation. Each entry is provided with a short annotation describing how it relates to the topic. The *sources* generally fall into five, often overlapping types:

Books

- Journal articles

- Conference proceedings
- Videos
- Computer files available on the Internet

By *subject* these address:

- Electroacoustic music aesthetics
- Electroacoustic music composition practices
- History of electroacoustic music
- MIDI-based tools for composition and performance
- MIDI: technical details

The following primary sources are available in ***book*** form:

- Textbooks
- Dictionaries
- Bibliographies
- Collection of articles, usually not focusing on a particular topic, but instead dedicated to a wider subject, for example, Computer-Generated Music
- Manuals/introductions into MIDI, aimed mostly at composers
- Overviews of development of a certain MIDI-related subject, e.g. MIDI composition, MIDI synthesizers, etc.

The books are also divided by *discipline* into the MIDI-related books, Aesthetics, and Social Science research sources.

The ***articles*** can be divided into the same groups as books. The following groups also apply:

- Viewpoint on a particular topic
- Conference reports
- MIDI-based product presentation
- Interviews with composers

The MIDI-related sources target a number of different circles of readers: composers, software engineers, hardware engineers, performers. Notably, very few aim at the musicologist. A characteristic trait is an abundance of sources dealing with the creation and performance of music but written by non-musicians. The absolute majority of sources are descriptive (narrative) in their approach and analytical sources are rare. No source constitutes a prior major study of the research topic. Instead, the majority of topic-related entries contain a certain segment bearing reference to the subject of this research, its size ranging from a phrase to a book chapter.

Starting with Anderton's "MIDI for Musicians" in 1986, there has been a continuing tradition of textbooks on MIDI which went hand in hand with the rapid incorporation of MIDI into electroacoustic music textbooks. The presence and evolution of MIDI-based composition started receiving attention in the sources, originally with the composers sharing techniques they used in writing a particular piece. Later, as certain compositions gradually became MIDI "classics", analyses of such pieces were incorporated into textbooks.

Several books bear specific importance for this research. "On the Wires of Our Nerves: the Art of Electroacoustic Music", edited by Robin Julian, was the first book entirely dedicated to the aesthetics and theory of computer music published when MIDI was fully incorporated into composition. A compilation of articles, it presented a collection of essays which were either presenting one composer's view of a certain side of electroacoustic music, or a brief (as the format demanded) aesthetic study by a musicologist. The book is important for understanding aesthetic discussion of the mid-late 1980s electroacoustic music, but contains little data or analysis.

The spread and evolution of MIDI-based composition tools are comprehensively presented in Manning's "Electronic and Computer Music." Rapid evolution is also well documented by the "Presentations of MIDI-based Products in Computer Music Journal" section of the bibliography.

The critical discourse of the relevance of MIDI to electroacoustic art music began in 1985 with the article "Musicians Make a Standard" (Loy 1985) in CMJ. Unfortunately, the above-mentioned sources as well as "The Impact of MIDI upon Compositional Methodology" (Yavelow 1986), "The Dysfunctions of MIDI" (Moore 1988) and several others stand out as rare examples of broad spectrum and in depth discussion of MIDI-related issues.

Of particular interest are interviews with the composers. These sources center on "The Computer Music Journal" and its publications. However, the interviews rarely touch upon the composer's evaluation of his/her interaction with the MIDI technology. Therefore, conducting further interviews on these little explored issues was central to our research.

Testing the hypothesis of a possible style change in electroacoustic music required finding sources able to deliver enough information to support or reject the concepts of the hypothesis. Since the lack of written sources on the subject ruled out the possibility of a bibliography-based study, the only other way possible was to extract the ore directly from the composers.

2.3 Data Collection

2.3.1 Intention of the Study

The results of this survey accurately reflect the attitudes and experiences of a sampled group of composers. Although it is not strictly possible for the results of a non-random survey to extrapolate these results for the global composer population, the purposive selection used in this study, a sufficient number of respondents answering each question, and a high level of commonality of experiences make it very likely to encounter the same trends existing in the entire possible population.

2.3.2 The Study Design

Due to the reasons explained above, the collection and processing of the data for the study evolved to include the following stages:

3. Data collection
    - 3.1. Survey design
    - 3.2. Selection of the survey sample
    - 3.3. Development of the questionnaire
    - 3.4. Research of potential respondents
    - 3.5. Conducting interviews (travel)
4. Data classification (creating database)
    - 4.1. Conversion of the results of each interview into a quote file
    - 4.2. Entry of the results of each interview in the statistic file
    - 4.3. Classifying quotes by subject in subject files
5. Data analysis and interpretation
    - 5.1. Creation of statistic tables
    - 5.2. Conversion of subject files into subject essays through analysis
    - 5.3. Consolidation of subject essays into chapters

2.3.3 The Survey Design

The social variable[2] of the study was the electroacoustic music composer population. The research was designed as a *longitudinal study*[3]. The basic problem presented at the macrolevel of the study was 'Has there been any change in the behavior of the population over the period of time?' The conceptual form of the hypothesis can thus be diagrammed as follows[4]:

A = electroacoustic music composers

A **A**

Time 1 **Introduction of MIDI (Control Time)** **Time 2**

The study provided enough additional information to answer more questions at the microlevel. A *longitudinal comparison study*[5] occurs when the change is broken down and analyzed separately for tape performance oriented (prerecorded) and live performance oriented (often interactive)

[2] The group of the subjects of the study performing the researched functions.

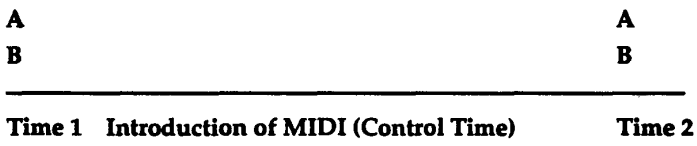
[3] The longitudinal research design involves two or more case studies of the same group with a period of time between each study (Bouma, 93).

[4] See Figure 6.5 in Bouma, 94.

[5] The comparison involves comparing one measure of two or more groups (Bouma, 96). When the comparison and the longitudinal types are combined, the longitudinal comparison research design is produced (Bouma, 99).

electroacoustic music. Here the behavior of two variables is researched: A = tape music composition; B = live music composition.

Note that the two groups are distinguished by the type of composition. The composers may often be the same for both variables. This problem is best presented by the following figure:



2.3.4 Selection of the Survey Sample

I. The population criteria

Only those composers who were active ***before*** and ***after*** the introduction of MIDI could be included in the studied population. Those who joined the electroacoustic music community after MIDI was introduced as well as those who did not compose music after MIDI equipment became available could only be present in either Time 1 or Time 2 on the figures above, and thus were not suitable to demonstrate the effects of the impact of MIDI.

Another restriction was set by the type of music the composer wrote. The qualifying subject would work with the ***electroacoustic*** composition media in both Time 1 and 2. Composing for acoustic instruments was not taken into the account.

The last restriction was set by confining the music realm to non-commercial ***art*** music. With all due respect to the other fields of electroacoustic music, the development of those fields went in ways different from the non-commercial art music, affected by different demands and phenomena. Were those cases to be presented in the same study in combination with the art music cases, they would obscure the origins and results of the findings.

II. The sampling model

The ***purposive sampling*** procedure[6] was selected to conduct the survey. The process of selection was non-random since the researcher did not and could not have a list of all qualifying subjects and randomly select the samples. Instead, a larger geographical representation was sought to diversify the population.

[6] Such procedure involves selecting of the subjects to be studied as opposed to random selection used in random sampling (Bouma and Atkinson, 143). In our study only four out of the forty-five subjects were personally known to the interviewer. The rest were selected accidentally based on their availability at the contacted locations. The selection of all of the subjects interviewed in the project was based on the eligibility criteria as stated.

The population of electroacoustic art music composers is characterized by internationalism of professional experiences when, for example, a composer who spent a significant part of his life in England, spends another part working in France and is currently employed in California. This 'traveling' career model breaks away from regionalism of art and blurs the differences in experiences.[7] Internationalism contributes to the homogeneity of the community which itself brings about consolidation of tendencies and a more even distribution of characteristics.

Thus the respondents[8] can be divided into the following groups according to where the respondents worked when they were introduced to MIDI:

- USA,West Coast (14)
- USA, East Coast and Canada (6)
- Europe (19)
- Asia/Australia/Latin America (4)

Those geographical boundaries have changed for most of the respondents, e.g. a person recently interviewed in San Diego (West Coast) worked in Paris (Europe) at the Control Time. As a result, in our study it is impossible to divide the population into exact distinctive groups along geographical lines, but meanwhile a wider geographical representation diversifies personal experiences and helps to detect the common trends around the world.

Since it is hardly possible to estimate the ultimate number of composers meeting the selection criteria,[9] and make the random drawing based on that data, the purposive sampling procedure was selected as the means to collect reliable data.

The surveyed segment of population has achieved the highest level of visibility among and, possibly, influence on the overall population. As can be seen by the presence of their works on concert programs, abundance of articles in professional media and the teaching and administrative positions at the research centers and colleges the majority of them occupy, these respondents have generally succeeded in the field.

Sociology traditionally does not hold the percentage of population interviewed to measure the reliability of the survey.[10] However, a sample of forty-five respondents satisfies the two basic

[7] The same trend was noticed during the survey that CMJ conducted with their 1985 questionnaire "They [fourteen respondents] live in the USA, France, and Germany, although their countries of origin include Italy, India, Argentina, and Poland, as well" (Symposium on Computer Music Composition, 40).

[8] Forty-three composers who answered this question.

[9] The ICMA membership, CMJ and Keyboard magazines' circulation, which usually cover the largest segment of electroacoustic art music community may not be used for this purpose as they do not represent the precise number of composers satisfying the selection criteria.

[10] One common misconception is that the adequacy of a sample depends heavily on the fraction of the population included in the sample -- that somehow 1% or 5%, or some other percentage will make a sample credible. "A sample of 150 people will describe a population of 15,000 or 15 million with virtually the same

rules about sample size: "About thirty individuals are required in order to provide a pool large enough for even simple kinds of analyses. You need a sample large enough to ensure that it is theoretically possible for each cell in your analytical table to have five cases fall in it" (Bouma, 128).

The general evaluation table used in this research has six as the regular number of cells (number of categories multiplied by the number of Times) on it:

X - a respondent from the sample
Y - a question from the questionnaire

For X * Y, Time 1 = pre-MIDI; Time 2 = post-MIDI (introduction)

	Yes	No	Other
Time 1	Cell 1	Cell 2	Cell 3
Time 2	Cell 4	Cell 5	Cell 6

By multiplying 6 * 5, 30 respondents are to have a valid answer.

2.3.5 The Questionnaire

The interview questionnaire is subdivided into three sections:

Part 1. ***Composition and Performance Methodology***
focuses on the historical context and describes the general practices of creation and realization of compositional works before and after the respondent's introduction to MIDI.

Part 2. ***Timbre; Form/Structure; Improvisation; Notation***
concentrates on various properties of style usually affected by the use of MIDI.

Part 3. ***Standardization; Accessibility; Reception of MIDI***
addresses the composer's response to the shift from the pre-MIDI to MIDI technology focusing in the first two subsections on the most prominent features of MIDI devices.

The questionnaire underwent a series of changes. The original text was influenced too heavily by the study's theoretical approach and was therefore awkward. Better phrases, appropriate to conversational style were found to replace the scholastic ones. Some questions not directly related to the study were taken off the final version of the questionnaire,[11] sufficiently short and well-structured.

degree of accuracy, assuming that all other aspects of sample design and sampling procedures were the same" (Fowler, 33-34).

[11] Figure 1.

Figure 1. Questionnaire.

PART 1

Composition and performance methodology

Please describe the electroacoustic pieces you wrote in (late) 1970s[12]-early 80s.

What were the media and setup for their performance?

What composition methods did you use writing those pieces? (Algorithmic, serial etc...)

Did you use non-MIDI environments for composition and performance after you were introduced to MIDI? Why?

Have you composed pieces for live/interactive performance?

Has the availability of MIDI tools influenced your choice for writing live (vs. tape) electroacoustic pieces?

PART 2

Timbre

Did you develop your own timbres before MIDI?

Did you continue to create your own timbres after you started to use MIDI equipment?

What was (and is) your opinion on the ready-made timbres , 'presets', which became available in the MIDI generation of equipment?

Did you use them?

Are you satisfied with the quality of simulation of acoustic instruments synthesized in MIDI equipment?

Have you noticed a change in the number of different timbres used simultaneously in your MIDI vs. non-MIDI pieces?

[12] If appropriate.

(Figure 1 cont.)

Form/Structure

How do you come up with the form of a piece? Do you have a certain general idea before starting to write the piece, or it evolves as you work on the piece?

How do you use algorithms in your compositional methods?

How does the musical form of your pieces depend on algorithms?

Is there any connection between your use of MIDI tools and the form of the piece it was used in?

Improvisation

Is it an important part of your compositional method?

How would you compare pre-MIDI to MIDI possibilities for improvisation and your reaction to it?

Notation

What kinds of musical notation have you used (traditional, graphic, syntactic etc..) ?

Did you benefit from the availability of MIDI notation software?

PART 3

Standardization

Did you experience problems as a composer arising from incompatibility of the hardware before MIDI?

Did you try to fix them by connecting, cross-patching those incompatible components?

Did the state of pre-MIDI equipment encourage you to develop your own devices, elements that you later abandoned completely or replaced with the MIDI ones?

Accessibility

When you adopted MIDI tools, was it easy to learn, install, implement them into your composition environment?

How would you compare the user-friendliness, accessibility of MIDI interfaces and devices to pre-MIDI tools?

(Figure 1 cont.)

Reception of MIDI

Did you expect the appearance of a standard like MIDI in the mid-1980s?

When and where were you first introduced to MIDI?

When was your initial impression of MIDI?

Has your evaluation of MIDI evolved over the years?

Did you try to transfer what you discovered without MIDI into MIDI?

Was the transfer successful?*

Do you have any pieces, different versions of which are written using MIDI and non-MIDI tools?

What are the advantages and limitations of MIDI and MIDI-based tools for you as the composer?

What is you primary interest in electroacoustic composition?

Have you noticed a shift in that interest from one property of your style, e.g. timbre, form, performance media, tape vs live realization, to another as you started to compose with MIDI tools?

Optional questions

What musical and non-musical (philosophical, scientific, visual art) traditions have influenced you? How is that reflected in your composition style?

Can you tell a MIDI from a non-MIDI piece?

Permissions.

1. Do you permit me to use your name in the paper resulting from this research when discussing a particular answer or a piece of information you conveyed during the interview?

2. Do you permit to use information from this interview in other research projects or you'd like to confine the use of it to this particular project?

3. Do you agree to having your name mentioned in the list of people interviewed in the course of the project?

A number of composers interviewed in the course of the project never used MIDI and have continued to employ non-MIDI environments after they became introduced to MIDI equipment. For them, a part of the questionnaire was irrelevant, e.g. the questions about the transfer from non-MIDI to MIDI-based tools. Another group included responses of composers who had never used algorithmic composition. The lack of answers by those groups had a quantitative but not a qualitative effect on the corresponding conclusions.

2.3.6 The Interview Process

The questionnaire is only part of the actual number of questions asked during the interviews. Often more questions were needed to complete the answer. When the respondent digressed or provided inadequate information, the interviewer probed incomplete answers for clarity.

During the interview, the questions were not tied to the order on the questionnaire making it easier for the respondent to dwell on a problem related to the context as opposed to moving to the next immediate section and coming back to this problem in future. This technique allowed for converting an otherwise drudging interrogation into a conversation where the respondent delivered a continuous flowing monologue following the points given by the interviewer.

In order to focus the answers, the respondents were informed of the following points:

> "1. We will talk only about you, your works and your opinions. There has been a lot of material written about the way things happened in general in electroacoustic music in the 1980s. For this study it is important to know how you personally respond to those events.
>
> 2. The majority of my questions are yes, no or a short answer. There are a lot of things we can discuss but should we need to go in depth in one of the areas I will make sure we will, so please follow my questions."

Of forty-five interviews,[13] one was conducted entirely in French, several others used the questionnaire translated in French as an aid during the interview. All other interviews were done in English.[14]

The length of interviews varied from 30 minutes to 2 hours and 30 minutes. An average interview would usually last around 1 hour 15 minutes. Despite the emphasis on depicting personal albeit professional experiences, the interviewer has never met a respondent's refusal to answer a specific question or talk about a certain subject.

The interviews were conducted with composers who are currently at the following research centers:[15]

[13] The actual number of conducted interviews totals at forty-six: one interview could not be used in the study for lack of sufficient information.

[14] For the entire list of respondents, see Appendix A.

I. Domestically:

CCRMA, Stanford University*; CNMAT, University of California, Berkeley*; Department of Music, San Jose State University; CRCA, University of California, San Diego*; CEM, Mills College, Oakland*; CEAIT, California Institute for the Arts, Valencia*; CREATE, University of California, Santa Barbara*; CPEMC Columbia University; Princeton University; State University of New York, Buffalo; Brandeis University.

II. Internationally:

IRCAM, Paris, France*; ZKM, Karlsruhe, Germany; STEIM, Amsterdam, Netherlands; Lab de Mechanique et d'Acoustique, CNRS, Marseilles, France; Group de Recherche Musicale, Radio France*; Universite de Paris VIII, France; University of Osaka, Japan; Latrobe University, Melbourne, Australia; Auckland University, New Zealand; Simon Fraser University, Vancouver, Canada; University of Oslo, Norway.

2.3.7 Database Design and Data Classification

Database spreadsheet or the front file corresponds to an individual file for each composer. The general ***statistics*** file has questions in horizontal tiers and composers in vertical categories.[16] Each intersecting cell has the data element and, if necessary, pointers to the citation in an ***individual*** file.

4 types of data values are entered into the front database file:

a. factual (year, place)
b. nominal ('Yes', 'No', 'sometimes')[17]
c. comparative ('Better', 'Worse')
d. itemizing (lists such as "Limitations", "Advantages" etc.)

'N/a' data value stands for three different values: 'not answered', 'not applicable', and 'not asked'. In this study, it eliminates this cell from the subsequent comparative and quantitative research. To clarify: if the respondent's answer is negative and it is meant in the meaning of the answer, then the value is 'no'.

Inevitably some questions during an interview get looked over or answered unclearly. I have attempted (with a varied degree of success) to retrieve the necessary missing data from the respondent by e-mail.

[15] * marks the institutions where the interviews were conducted on location.

[16] See Appendix B.

[17] We had to divide 'Yes' into 'Common', 'Rare' for one of the questions.

Each interview consists mainly of communicative, narrative unedited speech. Converting such type of information into scientific data presents these typical problems: excess words ('you know', 'sort of', 'kind of', 'and' and 'so' used meaning-free in linking function); repetitions; lack of beginnings or ends of phrases; loss of contents when communication is channelled non-verbally.[18]

The ***subject*** files are compilations of answers to a particular question from all 45 respondents. Very often the same answer may be applicable to more than one subject in which case it ends up in each of the appropriate subject files. The subject files set up the framework for the chapters of the study as well as provide data for the subject tables.

Each of the tables contains both numerical and percentage data corresponding to one or more questions. Percentage is calculated for all **available** answers, thus excluding all 'n/a' cells from counting.

The extensive use of quotes from the interviews is characteristic of this study. Unlike other studies where the quotes from the sources assist the research, here the excerpts ***are*** part of the results of this research. Collection and preservation of information pertinent to the topic is a significant part of this research project. These quoted materials are not available in written, or otherwise documented form, anywhere else.[19]

2.3.8 Data Privacy Issues

Issues of privacy and consent come up when the findings of a social study are presented in public. The aim of this study is, first and foremost, to present objective results portraying a collective, generalized response. In the eye of the public, an opinion of a person with higher visibility or power status can bear more authority and thus unobjectively influence the judgment. To our study, visibility and status are irrelevant. In accordance with that, all interviewed subjects are kept anonymous. Their privacy is protected by coding, meaning each composer is assigned a permanent random number between 1 and 45. The interviewer and the university advisor supervising the study keep the copies of the original coding list. The 'XXX' symbol substitutes the titles of the pieces and custom-developed devices mentioned by the composer in the quotes from the interviews.

After the interview each interviewee was asked the following three permissions:[20]

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[18] Characteristically, non-native speakers of English tend to express themselves more clearly due to selective (as opposed to free-flowing) character of their speech.

[19] Some of the excerpts are repeated more than once throughout the dissertation because the answers they contain apply to more than one research question.

[20] Figure 1.

1. Do you agree to having your name mentioned in the list of people interviewed in the course of the project?

2. Do you permit the interviewer to use information from this interview in his other research projects or you'd like to confine the use of it to this particular project?

3. Do you permit me to use your name in the paper resulting from this research when discussing a particular answer or a piece of information you conveyed during the interview?

All composers granted the first permission. Several composers did not permit the second statement and the interviewer will proceed according to their wishes. A significant number of interviewees did not want to see their name connected with a quote from their interview without their approval. Just like in the previous statement, the interviewer will proceed according to each subject's preference: throughout this entire study, none of the quotes bear any names.

Chapter 3

Historical, Technological, and Aesthetic Context of MIDI

3.1 Aesthetic Discourse Relevant to This Study

3.1.1 Introductory Comments

The intensity of interaction between the conceptual and technological components of the musical process with electroacoustic media and the search for the place of electroacoustic music in the tradition of art music bring about some pressing aesthetic questions, summed up best by Logue: "What does "music" mean? Does it mean the same thing it did 200 years ago? What is my definition of music? What is the juries'? What is the audience's? Shall I move the soul or shall I demonstrate technology? Are there other art forms suffering the same fate? Is technology the new art?" (Logue, 15)

The aesthetic discourse in electroacoustic media has influenced both the development of compositional concepts and compositional practice (itself manifested in the use of tools). It involves several groups of issues and form the topic of our investigation.

3.1.2 Composer / Performer / Audience Interaction

The differences between practices, tools and musical performance of acoustic and electroacoustic art music[21] are significant. However, a lot of aesthetic issues remain the same across the electricity borderline. At the very beginning of a major aesthetic study in electroacoustic music, Heifetz declares "The fundamental social function of any compositional idea must be that of communication" (On the Wires..., 11). The composer's message is channeled through the performer to the listener and back. The full functioning of this creator/performer/appreciator communication triangle has been the basis of various kinds of music. In electroacoustic music[22]

[21] In particular, the bizarre, from the traditional point of view, idea of a tape concert.

the middle stage of the process may get truncated as the composer and the performer can be the same person, but the idea of communication, of information exchange is still vital.

In many cases imperfection of technology, seen as the impossibility to create live instead of studio performance (Keane 1979, 44) as well as the complexity of language demanding particular background of the audience, impaired communication lines and put electroacoustic composers in what Heifetz calls "isolation" (On the Wires..., 12). But not everyone considers that a loss. For example, Kasdan and Appleton praise that direct performer-less communication with the audience in electroacoustic music: "The significance of electronic music, in which the composer deals directly with the sound, lies not in the use of new material (concrete or electronically-generated sonorities) but in the fact that the composer is communicating directly with his audience without an intermediary" (Kasdan and Appleton, 23). In fact, both opinions add up to describe the real situation: from the point of view of traditional, live performance practice, it is an 'isolation', but it is also a case of direct communication when the listener receives the precise contents of the composer's message through the performance, faithful in its correctness to the original idea.[23]

Wide availability of tools coming with the MIDI revolution in composition technology significantly diminished the self-induced isolation of electroacoustic music.[24] It also facilitated the spread of live electroacoustic tradition with all three components of interaction restored. [25]

3.1.3 Tool / Composer Interaction in Music-Making Process

Dependence on extramusical, technological elements, as correctly observed by Morthenson,[26] is the fundamental characteristic of electroacoustic music. The debate over the influence of composition tools on the musical product is endemic to electroacoustic music while rarely present when discussing other areas of art music. The limitations of acoustic instruments, such as the range, performance techniques and the number of simultaneously produced voices, have always been part of the tradition of acoustic composition. However, electroacoustic composition added three more factors putting the composer into closer contact with technology:

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[22] As often in folk music.

[23] In fact, the tape performance in electroacoustic music is not far from the acoustic tradition of composer /performer, which will include most of Baroque instrumental composers as well as quite a few in the 19th and 20th century, Liszt, Paganini, Rachmaninov, Gottschalk et al.

[24] See Chapter 5.3 "Social Benefits of MIDI Equipment."

[25] See Chapter 6.3 "Live Interactive Electroacoustic Music and MIDI Tools."

[26] Morthenson, 66.

- rapid evolution of the instruments
- composer's access to the development of the composition tool
- composer often being the first and final performer of the piece

The realization of a compositional idea by means of tools may both differ from or conflict with the original idea. Devices may enhance or pervert the idea of the composer, but no matter how this is assessed, the result is an interpretation: the idea interpreted by the tool. In fact, humans and devices operate with different sets of values. "People and machines neither hear nor make the same music. Machines measure and generate exact amplitudes, frequencies, time durations, and spectra. However, people hear and create music with subjective qualities such as rhythmic pulses, prettiness, illusions of the ear, imitations of sounds, models of nonmusical reality, freely rendered mathematical relationships, familiarity, archetypal symbols, and the stimulation of senses other than the auditory" (Janzen 1986, 83). Research efforts undertaken throughout the history of electroacoustic music can be summarized as attempts to resolve that difference. From the aesthetic point of view, the symbiosis of art and technology in electroacoustic musical process leads to the problem of integrating nonscientific elements of art originating in "anarchy" into a "rationalistic" atmosphere (Morthenson, 67).

Some composers believe they assert complete control over the act of composition keeping the role of the tool to being exactly that, the tool -- a device to execute the will of imagination:

> "The tools come as a continuation of something, as a result of imagination. The imagination directs the use of the tool. If I don't have imagination, the tool wouldn't have the imagination [either]. It only has possibilities. When the relation between imagination and the chosen possibilities is being established, at once it triggers something, it triggers freedom which means that because of having that tool we have the freedom to work with something" (36:*A445).

However, the range of possibilities is limited by the tools. If a device works within a certain range, or produces a certain operation, this dictates the limits and, at times, direction of methodology. In a particular case Keane observes how electroacoustic composition in the 1970s frequently depended on the use of switches and knobs, where the physical ease of operating a knob leads to its frequent use. He cites the popularity of using glissandi in electroacoustic music as an example (Keane 1979, 47). In our survey a number of composers recognized the limits of their possibilities with a particular tool.

> "I bend my music to work with these existing tools I have. It's not that I want to do something and I am working with this synthesizer wishing that I have this other synthesizer. I have some ideas but I'm willing to change them so that I can make them work with what I have. Otherwise I would just sit here and wait for the magical tool that does everything" (33:*B100).

The scope of control of the detail is also influenced by the tools. In the pre-MIDI electroacoustic music studio, one would allow a wider margin of acceptance for sounds produced by the analog equipment whereas in software synthesis the level of precision has been much higher.[27]

[27] Keane even questions if the improved computer graphics in the late 1970s allowed "too precise a

Focusing on the tools, when the interest in devices eclipses the aesthetic goals,[28] is frequent in electroacoustic music. "Roads: What, in your view, is the most unhealthy aspect of computer music? - Lansky: It is the extent to which there is an obsession with the machine rather than with what it produces. I have heard too many discussions among computer music people who were only concerned with software and hardware without ever considering what kinds of pieces they were producing. [...] Good machines and better software certainly make life easier, but there is not a one-to-one correlation between the quality of pieces and the tools used to make them" (Interview with Paul Lansky, 23).

Semegen asks the question about the worth of electronic music in relation to the tools used to make it: "Do we, or should we, listen, respond to, and evaluate electronic music as music per se, or should such music be perceived from the vantage point of a mystique of appreciation of advancement, complexity, and novelty of techniques and gadgetry used to produce the sounds?" (Semegen, 32). It needs to be added that despite the major involvement of technical issues in the decision-making process, the final outcome of the piece is still under the control of the composer: (s)he is free to modify, rearrange or entirely abandon the work if the aesthetic conscience tells the composer to do so (Helms 1985, 8).

Logue goes even further equaling aesthetic contents to music itself, excluding technology from it entirely. He sees the problem discussed here as the widening of the gulf between music and the technology that creates it. MIDI, in his opinion, and "the saturation of commercially available MIDI devices" has deepened the problem by transforming electroacoustic music "from an elite genre to a folk art -- an equally valid form, but one inherently abused. It is much easier to compose a pop cliché to accompany your new computer graphics than it is to hire a trained composer to write a true composition" (Logue, 15). I disagree with the notion of separation between music and technology: there is a constraint, sometimes a conflict, but both elements are needed to give birth to a piece. Composition in electroacoustic music, more than in other kinds (traditional art, commercial, folk) is a compromise between the aesthetic and the technical in its creation.

Although none of the respondents or the written sources has attempted to justify superiority of tools over aesthetic ideas in composition, the tendency to often focus on technical rather than aesthetic realization of the piece is present in the literature and the answers. In fact it is not the interest in the technical tools but the lack of sufficient interest in the aesthetic issues that is a problem with the electroacoustic music discourse. Rarely one sees a discussion of aesthetic properties of electroacoustic music composition discussed at the level and volume of discussion of the technical means used in its production. Written sources available on the subject, books, articles in the magazines, proceedings of conferences overflow with the material on technical

conceptualization" in (Keane 1979, 51).

[28] Heifetz calls this phenomenon a "malady whose pathology can be observed in the tendency to focus attention almost exclusively upon technological rather than musical matters" (Heifetz, 86). Also see Helms 1985.

aspects while underepresenting the musicological, or more general aesthetic issues of this kind of composition. Keane notices the same trend: "It has been observed from time to time in recent past that little attention has been focused on the practical aesthetic problems of electronic music composition, while an impressive amount of print and verbiage have been devoted to technical areas that presumably only support the higher level concerns of compositional aesthetics" (Keane, 43).

3.1.4 Differences and Similarities Between Electroacoustic and Acoustic Genres of Art Music

On the surface many electroacoustic music composers have gone away the furthest from the traditional art music in which they were educated. Their tools, working process, compositional techniques and performance situations are vastly different from those in acoustic music. One may speak of the *New Tradition* where achievements of the prominent electroacoustic composers not yet recognized as such by the mainstream traditional school influence the practice, originate discourse, and create a continuum of a new style.

The separation of the two traditions was caused by differences in the tools for composition. From *Musique Concrète* and through the flourishing tradition of computer synthesis, the separation was clear.[29] This schism was bridged in certain cases, e.g. a common electro-acoustic genre of a computer-generated tape with a live acoustic performer (Stroppa, others), or use of electroacoustic instruments in a predominantly acoustic environments (Messiaen, Saariaho, others).

Through their design reminiscent of acoustic instruments, MIDI instruments paradoxically brought the two traditions closer together, but exactly that feature was hardly welcome. In general, MIDI devices that were able to capture the flexibility and expressivity of acoustic tools, for example wind/breath controllers, powerful notation programs, had quite enthusiastic response whereas features of MIDI devices reconstructing limitations of acoustic instruments, e.g. fixed-pitch keyboard scale, have been received negatively.

3.2 Evolution of the Technology

3.2.1 Mainframe Computers and Analog Synthesizers.

In the beginning of the 1980s the traditional mainframe computers used for composition purposes since the late 1950s and the analog sound synthesizers (keyboard and non-keyboard controlled) were the essential parts of electroacoustic music-making.

[29] Pope outlines several differences between these two traditions, among which: separation of composer and performer roles in the traditional music vs. frequent combination of the two in the electroacoustic music; popularity of real-time improvisation with electroacoustic devices (Pope 1994 in CMJ 18[3], 7).

The merger of those two elements into one versatile computer music system started to take place at the turn of the 1970s replacing the tape recorder as the primary device for electroacoustic composition. Occupying an increasingly smaller space, tape manipulation techniques, their principles virtually unchanged since the 1940s, have continued to exist up to the present day. However, the focus of research efforts in the 1970s worldwide had switched to mainframe computers and analog synthesizers.

3.2.1.1 Analog Synthesizers

Moog and Buchla were among the original analog voltage-controlled[30] synthesizers born in the 1960s and continuing to survive and develop throughout the 1970s and early 1980s. Three types of sound generators, usually through a microphone, were used in these synthesizers: *voltage-controlled* oscillators, noise generators and external analog input. Up until the advent of MIDI, most of these synthesizers were monophonic in the sense that there was only one sound produced at a time. All connections between different synthesizing parts were done manually using patchcords.

Synthesizer manufacturers in the early 70s started to gear their equipment towards live performance by reducing their size and introducing more accessible interfaces to the instruments. MiniMoog, ARP Odyssey and Synthi AKS were among those. Patchcords started to be replaced by front panel dials and switches representing internally wired connections. The programmable synthesizers introduced in the second half of the 1970s with Sequential Circuits Prophet 5, had digital banks of settings in an otherwise all-analog synthesizer allowing storage and easier change of patches. Still, these synthesizers continued to have the same limitations as all other analog synthesizers:

- crude implementation of subtractive synthesis
- low level of precision of filters
- single amplitude envelope for the whole sound
- unstable oscillators
- incompatibility of different brands

3.2.2.2 Computers

MUSIC programs (e.g. MUSIC IV, V, X, etc.) and their offsprings were in the center of music software development throughout the 1960-70s. Those programs provided computer facilities for additive synthesis, refined by external filter and storage units. By the beginning of the 1980s, MUSIC programs ran in computer music systems in a couple dozen of electroacoustic labs around the world. Frequency modulation (FM) synthesis pioneered by John Chowning in the late 1960s was developed further in the 1970s and subsequently implemented into MUSIC programs.

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[30] The voltage control meant that the voltage generated by the envelope generator of the synthesizer is applied to a control input of the amplifier to create the sound's amplitude.

Several waves of compositional devices promised to revolutionize the industry but did not succeed. Their failures were mostly due to common problems of mainframe computers impeding accessibility and market appeal:

I. Low fidelity of digital synthesis

MUSIC V-X programs employed additive synthesis. The comparatively low sampling rate used in MUSIC programs, the use of converters with even lower sampling rates restricted the fidelity bandwidth of synthesis to, approximately, one quarter of what was needed for adequate accuracy. Upper and lower ranges of frequencies were subject to various kinds of distortion.

II. Long processing time

The complexity of sound synthesis processing results in a large number of operations to be computed. This level of complexity and the (relative to now) low speed of processing led to an extensive amount of time needed for executing a compositional activity. "On a typical mainframe computer of the 1960s or 70s upwards of ten or twenty minutes of processing time could be required for each minute of sound. [...] It was not unknown for this ratio to increase to 100 or even 200 to 1" (Manning, 224).

III. Technical difficulty

Absence of programming skills excluded many musicians with limited mathematical background from using computer music systems for composition. However, some musicians found little difficulty adapting.

IV. Lack of financial accessibility

The non-commercial nature and the high cost of the equipment made mainframe computer systems inaccessible for individuals. Those systems were normally found only in research institutions.

V. Size

The large size of mainframe computer systems rendered them useless for live performance projects and required specific and expensive maintenance available only at large research labs and other institutions.

3.2.2 All-Digital Music Systems in the 1970s-early 1980s

I. Microprocessors

The first two generations of computers which appeared in the late 1950s-early 1970s were based on vacuum tube, and later, transistor technology. Aiming at further increase of power and reduction of size, technological research in the 1970s focused on developing integrated circuits.

The first microprocessor introduced in 1972, Intel 4004, was quickly followed by faster and more sophisticated units. With functions of previously separated parts incorporated into one, compact microprocessor, it took but a few years to add I/O interfaces, memory modules and see the first commercial microcomputers enter the market.

II. Up-market digital synthesizers

Synclavier, appearing in 1975 as the first all-digital synthesizer, proved a long-standing success in electroacoustic music. It allowed multi-timbral digital synthesis in compact form made possible by microprocessing technology, and also had a sequencer to store performance data. Synclavier was upgraded and re-released by New England Digital Corporation many times to later include editing facilities, an alphanumeric keyboard and hard disk drive. Synclavier's real-time sequencer which was able to reduce compilation time (a usual frustration for the composer), was met with particular excitement by composers. The instrument was commercially produced, but remained a rarity because of its high price.

Design of this instrument was user-friendly in the 1980's way: it spared the user the trouble of writing his/her own software and left almost all system exclusive information out of their reach. The same was true for the Fairlight Computer Music Instrument, another successful, but expensive personal digital synthesizer. Computer musicians, experienced in programming, were disappointed by the lack of access to the underlying software, which was setting a limit to the musician's experimentation with the tool.

Unlike FM and additive synthesis featured in the Synclavier, the Fairlight, introduced in 1978-79, used sampling for construction of timbres. Samples were available off the manufacturer's sound cards and could also be recorded directly into the instrument.

Several other competing commercial digital instruments which appeared in the late 1970s and early 1980s, including Buchla synthesizers, were less influential for the development of technology.

III. Mass-market digital instruments

Casio VL-1, the first all-digital synthesizer, appeared on the market in 1981. No matter how limited its capabilities were, low production cost and high performance of microprocessors determined the course of events in the synthesizer industry for the 80s. Analog synthesizers started to fade out of the market and became virtually extinct in the second half of the decade. Casio CT-701 which followed VL-1 within several months featured twenty preset voices, a sequencer, five-octave keyboard and a primitive input for external music information. Breaking away even further from analog synthesizers, the new CT-701 was polyphonic allowing up to eight simultaneous notes.

The development of digital synthesizers went in a similar direction to other digital audio tools, catching up with the latest innovations but very wary of the market appeal. The Yamaha GS generation of synthesizers, introduced the same year as Casio, incorporated FM synthesis in its voice generation system using analog circuits only for final filtering. Even though preset voices were not accessible for the user to change, the quality of preset FM voices was already a major step forward for this kind of the product. Milano, reviewing Yamaha GS2 in 1982, observes: "There's a common misconception about high-tech digital keyboard instruments to the effect that they are necessarily very expensive and nearly impossible to fathom at first glance. This misconception tends to leave the guy who's just going to be playing casuals either intimidated by or just plain disinterested in digital instruments. However Yamaha has recently unveiled a group of more affordable keyboards that use digital sound-generating circuitry and yet are more keyboard instruments and less synthesizers, making them readily accessible to players who aren't ready for a course in computer programming or who just don't want to bother having to figure out how to program basic sounds. [...] This approach to instrument design will be a plus to many people, but a minus to a few those who like getting their hands on the intricacies" (Milano 1982, 68).

Emulator I by E-MU, also introduced in 1981, was the first digital sampling synthesizer available in the mid-price range. Although the sampling rate had to be lowered for sound longer than 1.2 sec resulting in lower quality of sound, only two different samples could be used at a time, and editing facilities for the samples were limited, the keyboard showed a potential for the sampling synthesizers to be used in mass market.

IV. The IRCAM workstation and other unique digital systems

Among several non-commercially oriented synthesizer systems,[31] 4A-B-C-X produced at IRCAM in 1976-1980 came closest to answering the demands of electroacoustic art music. These systems were designed to be used in live performance, giving the composer ability to pre-program as well as control live multiple streams of electronic data. FM and additive synthesis were controlled by an external miniprocessing computer. 4X has been unsurpassed for its capabilities for real-time digital processing: it was able to process up to sixteen external inputs

[31] Including SSSP (University of Toronto, 1977), EGG (University of Aarhus, 1978).

simultaneously.

3.2.3 Microcomputers

With IBM holding the pre-eminent place in computer manufacturing at the time, the appearance of the IBM PC on the market in 1981 signified the start of commercial production of microcomputers for home use.

Although the audio capabilities of the IBM PC were underdeveloped, that did not hinder its quick domination of the mass market. Under the pressure of IBM PC dominance of the market, research at smaller computer companies started to dwindle. In order to survive, smaller companies had to produce IBM-like products. Few companies, such as Apple, Commodore, Atari, managed to continue their independent lines of products.

Among several rival microcomputers of the late 1970s generation, Apple II became the most successful model for music applications. The drawbacks of a very limited programmable audio generator of Apple II were offset by its graphics as well as facilities for external hardware input. A range of products expanding Apple II audio capabilities, such as programmable hardware oscillators, D-to-A converters, polyphonic voice cards, compatible music keyboards, editing and sequencing software became available on the market with the beginning of the new decade.

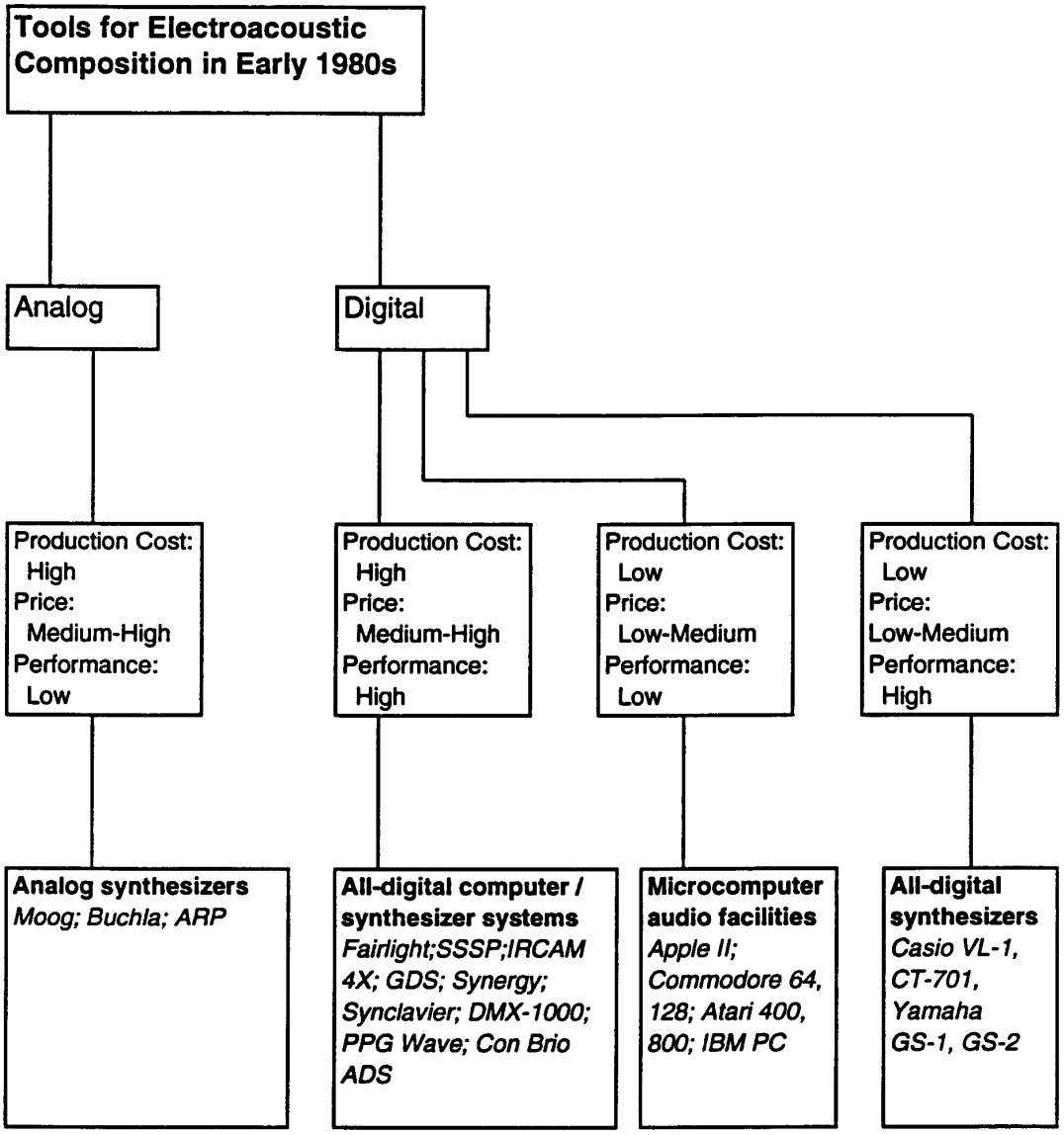
Four main factors advanced Apple's success with electroacoustic music, charting out the directions for the technological process for all of the 1980s:

- switch from analog to digital technology for audio synthesis
- musical keyboard/microcomputer symbiosis
- graphic computer interface
- availability of software and specialist products

With the PC market shifting from the professional to general user, user-friendliness of the equipment became a very important goal in the instrument design. "As operating systems and compilers have become well understood and standardized, much attention has turned to the design of the user interface. In the past, the user interfaces to many time-shared computer music systems tended to be rigid and one-dimensional. The design of a comfortable and flexible user interface is now recognized as a difficult and important endeavor" (Foundations, 372).

As the technology was moving from the analog to digital equipment, fidelity of sound remained a problem due to the low sampling rate of microprocessors and accuracy of samples. These problems were slowly solved during the 1980s by updating the sampling standard from 8 to 12, and later to 16 bit dynamic range (Manning, 271-274).

Figure 1. Pre-MIDI State of Technology.



3.2.4 Pre-MIDI State of Technology

Figure 2 demonstrates the state of the market for the composition tools at the time of introduction of MIDI.

In electroacoustic *art* music all groups of electroacoustic tools were present. Compared to commercial electroacoustic music, All-Digital Computer/Synthesizer Systems and the Microcomputer Audio Facilities groups, had a higher representation among the composition tools for art music for several reasons:

- composers' choice of more sophisticated tools available at institution-based electroacoustic labs
- extensive programming background of the composers, their familiarity with engineering side of the tools
- their willingness to trade the amount of time for more complex result

Education and research institutions which housed the majority of composition projects during the pre-MIDI period were likely to acquire more experimental environments with less regard to the price. These environments, often unthinkable in a personal studio for financial and technical support reasons, were present at almost all active electroacoustic centers. In the course of our survey, it has been found that 68% of the composers (30 out of 44) whose answers are available used computer environments for music composition in pre-MIDI years.[32]

	Yes	No
Used computer (software, algorithmic) environments for composition before MIDI	30	14
Percentage	68	32

Table 1. ***Pre-MIDI Computer Environments***

3.3 Demands of Electroacoustic Art Music

In 1987 when most of the electroacoustic music world has converted to the MIDI tools, Morrill said "Right now composers' needs are not being met. That's a specific disappointment I have had about computer music development in the past decade" (CMJ 11[3], 16). His words expressed a sentiment common, albeit not unanimous, among the art composers:

[32] Table 1.

- What were the demands of electroacoustic art music community?
- Were there ways proposed to satisfy such demands?

Appleton's article, published in the beginning of 1984, is a document presenting contemporary "composer/performer views of real-time performance systems." It states, "The recent interest shown at the 1983 ICMC in real-time performance systems demonstrates a new musical maturity in the computer music community. [...] Individuals whose research and design have led to numerous digital music systems seem to have suddenly become aware that the means do not justify themselves" (Appleton 1984, 48). The article is a statement supported by four other prominent electroacoustic composers focusing on the presence of the performer and thus live music using electroacoustic media. The article shows the disparity between this goal and the new generation of synthesizers which limits the range of possibilities for the performer. "A major problem of synthesizers to date, especially recently, is that they constrain the performer to expressing ideas through a limited set of gestures. [Ironically some electronic instruments from the 1930s to the 1960s were more flexible in this regard]. This "straightjacket" of most "over-the-counter" systems (for example, the piano type keyboard synthesizer), has meant that in many cases, the medium of expression is totally at odds with the musical idea" (Appleton 1984, 49).

The need for real-time digital signal processing of the sound is present in the majority of sources on the subject. Development of digital audio systems was seen as the future of electroacoustic music. Morrill explained his disappointment with MIDI tools by saying, "The promise of generalized real-time synthesis has not been realized." (CMJ 11[3], 16) The demands for **better speed, precision** (including high sound fidelity), **real-time synthesis** and **reliability** are brought forth by the editors of "Foundations of Computer Music" (Foundations, part 2). The authors point out that although "no study has yet been completed on the interconnection of several digital sound synthesizers" (Foundations, 196), the interconnection paradigm and the network of microcomputers appear to have great potential. Moorer, professing the future of electroacoustic music in a specialized digital audio processing station, points out the flaws in speed and affordability of the existing general-purpose computers (Moorer 1982, 16). Digital general-purpose fast synthesizers based on cheap "pipelined arithmetic processors" will carry the signal processing language general enough to run on other synthesizers. Compatibility, here referred to as 'interchangeability' is an essential component of this futuristic design (Moorer 1982, 16). Adding to the list of demands, Loarie points out the following flaws of pre-MIDI instrument design: **overgeneralization** aiming too broadly and incapable of configuring to answer a specific compositional goal; **lack of portability and real-time capabilities; undeveloped insensitive user interface** (Loarie, 7).

Even after extensive analysis of the MIDI protocol and tools, Loy in his important 1985 article hopes for "a system that combines a special-purpose synthesizer with a general-purpose computer to provide extensible musical data abstractions and operations. While the hard part of the systems integration would be accomplished this way, every level of the hardware and software of the resulting system would have to be in the public domain, be easy to modify, and be completely documented" (Loy, 23).

Analyzing existing design models for digital synthesizers and computers, Roads and Strawn point out the need for such a system to have more than 12 (10 fingers plus 2 foot pedals) voices, ability to manipulate recorded samples, and facilities for generating prepared scores and processing any incoming sound material with all components realized digitally in real-time (Foundations, 197-198).

The digital system resulting from this proposition should be able to play control commands for establishing interconnections and the same sample rate, and to exercise a score. Such commands may also be provided by the "hardware devices accessible to the user (keyboards, knobs, switches)" (Foundations, 198). The user must be able to send and receive information from each device in the system down one, or preferably more provided paths. The system would include sequencing facilities for recording and later editing performance done using the system.

The authors are reluctant to choose the best user input device citing successes of various kinds of such tools: the touch-sensitive keyboard; drawable screens; computer input devices including ports and keyboard; menus; knobs and switches, some of them touch-activated etc. Use of variable (as opposed to fixed) sample rate is proposed for systems employing AES standard sampling frequencies (44.1 kHz and 48 kHz) for audio transfer.

Home computing is acknowledged as a trend on the commercial market. "It is reasonable to expect that the market for such devices as these [PCs] will continue to grow and that their quality will improve. On the other end of the commercial scale, several fully digital keyboard synthesizers have reached the marketplace. As the music industry becomes more accustomed to digital technology, it is to be expected that more home organs, film-studio type sound-effects generators, and non-keyboard digital instruments (such as a digital wind instrument) will appear on the market" (Foundations, 203). The authors (as well as Moorer in his 1982 interview (CMJ 6[4], 17) profess that the VLSI (Very Large Scale Integration) chip is likely to be the engine of development, if it "becomes economical to implement previously unwieldy synthesis techniques in hardware" (Foundations, 203).[33]

Development of the standard was seen as a joint effort involving both manufacturers and the community that is going to use it. The desirable scenario is offered by Spiegel in her 1984 letter concerning the proposed standard for music editing systems. "Standard is common to some group. Therefore it is necessary for musical standards to involve input from as large and varied a group as possible or else to specifically define the group whose purposes the standards will be oriented and the nature of their use. [...] If computer-based musical tools are to dominate musical media of the future (which is likely), standards must be defined with ample input from nonacademic, non-institutional, even non-computer-using and non-European tradition musicians..." (Spiegel, 6).

[33] That prediction came fully true with Yamaha DX synthesizers.

A major attempt to create a compact general-purpose low-cost digital signal processing workstation for computer music was funded by the Systems Development Foundation. In 1982-1986 the SDF invested several million dollars into this project developed at four different computer music labs but no significant result came out of it. Disappointment with the outcome of the SDF research has been repeatedly voiced (Interview with Dexter Morrill, 15), "All this wonderful research of this group coming together to design the composer interface, having the Systems Development Foundation fund millions of dollars to MIT, to Stanford, to San Diego to come up with a common interface, to come up with a common approach. All of that went out the window" (14:*A222).

Development of a standard for computer music languages was also seen a necessary component of evolution of electroacoustic music. The late 1970s and 80s saw proliferation of software packages, their number growing exponentially with development of new hardware and software environments, their mutual compatibility often equals zero. Moorer warned in 1982 "We have already seen an explosion of languages for computer music, with no standardization, despite the efforts of some to bludgeon others into using their system. I have not yet seen a music language with a rich enough structure to support all the things we have been doing in music synthesis over the past 10 years" (Moorer 1982, 15).

3.4 Historical and Technological Context of Development of MIDI

3.4.1 Development and Introduction of MIDI

The majority of sources related to MIDI claim that the appearance of MIDI was the obvious next step of the development of computer and music technology. All factors for its appearance seem to fall neatly in place: "At the start of the 1980s the commercial market divided into three distinct sectors. Products such as the Fairlight and the Synclavier were opening up important markets for digital technology at one end of the spectrum, counterbalanced by a diverse collection of built-in or add-on synthesis systems for the microcomputer market at the other. In the middle lay by far the largest sector, still dominated by analog voltage-controlled synthesizers both large and small, but poised for what was to prove a design revolution of the utmost significance. ... the key to this development lay in the forging of an historic agreement signed by all the leading manufacturers of synthesizers world-wide concerning a common protocol for connecting different items of equipment together at the control level" (Manning, 274).

However, if one looks at the position of the market at the time, one will find that electroacoustic music was still on the margins of the contemporary music, largely confined to the boundaries of experimental art music. Both high-end and the middle-sector of the market electroacoustic instruments described by Manning were in fact too high-priced to be a real commercial success in

the mainstream.[34] Fidelity of sound and user-friendliness of devices fell in proportion to the price, with only the highest instruments in this hierarchy achieving those qualities at the level of the cheapest digital synthesizers to come in the mid-80s. That led to a low inclusion of non-art musicians into the potential market for these devices and a high involvement of art musicians.

The need for a standard can be explained from the performing popular musician point of view. "During the late 1970s, popular musicians approached instrument manufacturers to find a way to eliminate the need for the elaborate configuration of keyboards (usually of different makes) that had to be transported from concert to concert to assure maximum variety in the orchestration of various songs. Each synthesizer typically produced a characteristic sound quality, and the insatiable ear of the rock musician demanded an array of equipment that filled the stage with stacks and rows of keyboards. To play them all, the performer constantly moved from position to position as each new sound quality was needed. In 1982 the needs of commercial musicians were answered in the form of MIDI protocol" (Winsor, 12).

To clarify the relation of the development of MIDI to electroacoustic art music several questions need to be answered:

- Was the electroacoustic art community involved into the development of the next step of electroacoustic media?
- Was it informed of such development taking place?
- Was the coming development aimed to satisfy its demands and expectations of the tools for composition?

The answer to all three questions is 'No'.

The idea of MIDI, attributed to and promoted by Dave Smith, president of Sequential Circuits, was first introduced in informal contacts between Dave Smith, Ikutaro Kakehashi, president of Roland Corporation, and Tom Oberheim of Oberheim Electronics at NAMM (National Association of Music Merchants) in June 1981 (Smith, 70). The idea was to create a protocol similar to the Local Area Network (LAN) model, a computer system allowing exchange of data and auxiliary equipment between computers of different brands. "Local Area Networks had many of the characteristics the synthesizer group wanted. They can be relatively easy and inexpensive to set up and run, they can be non-hierarchical (i.e., they can handle all the computers in the network on an equal basis), and they clearly define the hardware requirements for physically connecting the computers and the data format of the messages that pass among the computers" (Rothstein, 11).

Following the interest created among the representatives of music manufacturing companies, the first feasibility study for the universal communications protocol was conducted. A larger group of companies became interested and consulted on the protocol. The first presentation of USI (Universal Synthesizer Interface) proposal took place at the AES (Audio and Engineering Society) convention in November 1981. Smith calls this presentation public, in which he requested

[34] Compared to what was to come.

"cooperation and feedback from the industry" (Smith, 71). It is dubious that the AES convention could serve as the appropriate public forum for the discussion of a protocol aiming to connect musical devices. Moreover, AES standards introduced before had been developed as such under the supervision of the independent professional society. That would set a proper example for the development of a protocol. Smith's paper, however, did not follow this case, did not set up proper organizational structure for the real public involvement and remained only a paper.

Smith's company organized a specific meeting at the next NAMM convention January 1982 to which it invited all synthesizer manufacturers. The meeting was attended by most of major manufacturing companies including Yamaha, Roland, Korg, Kawai, E-MU, Rhodes, Oberheim and others. The idea of the transfer of basic 'on-off' data designed upon a keyboard paradigm was not universally accepted yet. Some companies voiced objections to this simplistic approach demanding instead that "any universal protocol should be capable of carrying a far more comprehensive range of data, including any information necessary to configure the synthesis devices themselves" (Manning, 275). These demands directly related to the focus on analog and digital synthesis, characteristic of electroacoustic art music in the 1970s-80s and were ignored in the final design of the protocol. Smith dismisses all suggestions which contradicted Sequential's proposal. Immediately after this 'frustrating' (Smith, 71) gathering, Sequential holds a much more productive meeting with the same four Japanese companies that had already seen and apparently liked the proposal back in November 1981.

Throughout spring and summer 1982 Sequential continued work on the interface with active participation of its Japanese partners, in particular, Roland: "As a side note, most of the work on MIDI was done by Roland and Sequential" (Smith, 71). In October 1982 the preliminary version of the specification was ready and named MIDI (again Smith's idea). The first synthesizers containing MIDI, Roland JP-6 and Sequential Prophet-600, were released at the end of the year.[35]

The public, namely the art and commercial electroacoustic music community, did not participate in the development. All meetings, talks and discussion were held within the executive corps. The major venues of information exchange in the community -- International Computer Music Conference (1982, 1983), Annual Symposium on Small Computers in the Arts (1982), Computer Music Journal and Keyboard magazine -- were ignored. The first announcement in a major publication available to the general public appeared after the protocol was finished in the May 1983 issue of Keyboard magazine. This was an unusual way for a protocol which became a *de facto* formal standard, to appear, bypassing American National Standards Institute (ANSI) and without the public being informed.

The January 1983 NAMM convention was the site of the first official presentation of the protocol to the music industry, complete with the demonstration of the first MIDI devices. Live connection of Sequential Prophet-600 and Roland JP-6 on the stage of the gathering was the most remarkable point of the introduction.

[35] Sequential Circuits Prophet 600 and Roland Jupiter 6, both analog polyphonic synthesizers.

An announcement about MIDI appears in a widely available source for the first time in the May 1983 issue of Keyboard Magazine as part of its review of the presentation of new instruments at the winter NAMM '83. The one-paragraph description of the protocol is very general, giving an impression of much broader capabilities than what it can actually do. Nonetheless, the reviewer already assumes MIDI to be a standard and recognizes MIDI's "strong possibilities in the future" (Darter, 58).

The importance of MIDI was not yet as fully understood in the community as it had been in the industry. Dissemination of information about MIDI, aided by the publishing of MIDI Specification 1.0 by the newly-created International MIDI Association[36] continued throughout most of 1983-84.[37]

"M.I.D.I.: What it is, What it means to you" published in Keyboard's July issue[38] of the same year is the first article available to the general public. It gives comprehensive coverage to the protocol presenting its history, purpose, and technical specifications. Moog stresses MIDI's strengths, leaving aside its limitations and potential drawbacks. Such a view of MIDI is hardly surprising as the writer is also one of the MIDI manufacturers.[39]

The article also indicated the position of the various companies towards MIDI, dividing the manufacturers into three groups: those whose new MIDI-equipped devices would appear at the June 1983 NAMM show* (Roland, Sequential Circuits, Yamaha); the ones whose pre-MIDI instruments had been retrofitted to incorporate MIDI (Digital Keyboards [Syntauri], Moog, Octave-Plateau [Voyetra]); and manufacturers planning to introduce MIDI products after the NAMM show (Crumar, Korg, Linn, Oberheim, PAIA, Passport Designs, Rhodes). "Little immediate interest in MIDI", observes Moog, "exists among manufacturers of modular and experimental equipment" (Moog 1983, 25). He paraphrases Don Buchla's words who felt that MIDI was more limiting and less versatile than the Buchla systems.

Dozens of MIDI-controllable devices including Yamaha DX7 were presented at the June 1983 NAMM convention in Chicago. The trade show became the site of the breakthrough of MIDI instruments into the music industry. "Possibly the most revolutionary thing to take place in the world of synthesizers in years saw the light of day at this year's trade show. It had little to do with any one manufacturer's instrument, but rather was included on almost everyone's instruments. It was the MIDI [...]. It also enables you to interface directly to a home computer, and predictable there were a few people wandering around the convention claiming that they

[36] It is hard to say how easy it was to obtain the text of specification, (MIDI 1983) released August 5, 1983, the first announcement in CMJ about availability of it is in the last quarter of 1984 (CMJ 8[4]). The IMA itself was announced in the magazine only one issue earlier.

[37] For example, Sequential Circuits published a 45-page paper "The Complete SCI MIDI" on their implementation of MIDI, which it made available to public.

[38] The article was apparently written in May even though it appears in the July issue.

[39] Moog 1983, 24.

were planning or actually finished with the creation of MIDI-oriented software for various popular computers. Instruments sporting MIDI varied greatly in design and technology -- all digital, analog/digital hybrids, monophonic, polyphonic, and touch-sensitive instruments. A few of these had been available prior to MIDI but now included MIDI as a retrofit. Others we'd seen only in prototype from previously, and still others were fresh off the production line. Of course, MIDI has not been universally accepted. There are a few manufacturers who have developed their own interfaces or who have just taken a wait-and-see attitude. And there are some whose instruments don't warrant the cost of complexity of adding it" (Milano et al. 1983, 54).

Presented at Digicon (International Conference on the Digital Arts) in August 1983, MIDI still was not taken seriously by the community. "The presentation was well-attended at first, but he audience thinned as it progressed" (Digicon, 46). The CMJ reviewer parenthesizes "universal" indicating a note of disbelief when he describes MIDI as "the new "universal" digital synthesizer interface" (Digicon, 46).

The announcement of "The MIDI Standard" appeared in the winter 1983 issue (CMJ 7[4]) describing in approximately 250 words the purpose and specifications and making reference to "The Complete SCI MIDI" paper for more information.

In May 1984 IMA sponsored the MIDIsoft conference in San Francisco which attracted more than 200 participants, mostly independent MIDI users or smaller developers. "90% of the audience were serious software people who were more than capable of understanding the more technical aspects of MIDI spec" (Milano 1984b, 10). Since only the following four large manufacturers: Korg, Oberheim, E-mu, and Kurzweil were present at the conference, participants were highly disappointed about the influence both the conference and the community as a whole might have on the development of the protocol.

Throughout the sessions of the conference, the participants actively debated the limitations of MIDI, offering their solutions to specific problems. Despite active discussions, critique, insights and proposals coming directly from the community of MIDI users, the conference had no effect on the future of standard (Loy, 20).

It was not until the ICMC 84, held October 19-23 at the IRCAM that MIDI was highlighted among the topics of this symposium. The interest fueled by scant information and fast introduction of MIDI devices was considerable. Aside from the report of Robert Moog concentrating on details of the protocol, ICMC featured a special "Panel on Instruments, Interfaces, and Networks, including MIDI".

The panel was the first incidence of criticism of the standard coming from the art music community. As the CMJ reviewers observed, "The MIDI panel gave panelists and conference-goers an opportunity to provide critical feedback to the music instrument industry. [...] It was clear from the discussion that MIDI is not well suited for general musical research in computer music. This is due to the limited transmission speed, the impossibility of non-tempered pitches,

the lack of timbral information, and minor incompatibilities between different manufacturers' implementations of the standard. MIDI was not intended as an interface to control any synthesizer, analog or digital. Rather, it was conceived by a group of companies as a way to control their synthesizers in certain ways and to expand them through keyboards, sequencers, and personal computers. Within specific limitations, MIDI works fairly well, even though it is not an ideal solution. For instance, musicians complain about transmission delays that are data-dependent, the complexity of cabling, and the limitations in the lengths of the interconnections. On the other hand, MIDI has the undeniable advantage being a standard. This allows a musician to interface a new instrument without spending weeks on the problem" (Report on the 1984 ICMC, 31). The overall opinion of the panel after debating advantages and disadvantages of MIDI was that it need not be modified at the moment but needed extensions to cover art music demands.

Taking that opinion as the first and immediate expression of the general response to the appearance of MIDI one can see that the standard was not designed for the needs of art music. It was assumed and proven compatible with a lot of pre-existing concepts but contrary to the assumption popular in literature about MIDI (including Manning's above), it did not come as natural and anticipated result of the development of electroacoustic media. [40]

If only about one third of the composers report problems arising from incompatibility of pre-MIDI equipment,[41] then how would the whole art music community see something that "enables synthesizers, sequencers, home computers, rhythm machines, etc. to be interconnected through a standard interface" (MIDI 1983, 1) as the next major step in development of tools? The answer is that art music was more concerned with problems other than compatibility. In the historical line of development, MIDI was the deviation from the path; a deviation very useful to manufacturers but hardly concerned with needs of art music. The limitations of the resulting standard took it even further away from the demands of art music.

3.4.2 MIDI Equipment in the Mid-Late 1980s

3.4.2.1 Marketing of MIDI

MIDI was a perfect example of a marketing strategy of the created demand.[42] "We are being told we need a variety of products and services, including MIDI, because manufacturers need to sell them, and we fail to keep our objectivity about this only at our peril" (Loy 1987, 12). Rhea, contemporary to the events, observes a similar trend: "It's been ballyhooed to the point where it's a necessity" (Tom Rhea of Moog in Milano 1984a, 56).

[40] See Chapter 4 "Reception of MIDI in Art Music."

[41] See Chapter 4.1 "Incompatibility of Pre-MIDI Composition Tools" for more information on that.

[42] Instead of following the demands of the market, the industry, through extensive advertising, introduces the need and demand for a radically different product.

Without any major articles demonstrating the need for compatibility, lack of the critique of the reviewed instruments that had not had such features, Keyboard magazine in its review of MIDI in May 1983 suddenly finds that "it has become very important for the musicians to hook different instruments for synchronized operation, and, in order to do that, the instruments involved have to be compatible" (Darter, 58). Such conclusion can only be only the result of heavy pro-MIDI advertising. In fact, Moog's article which appeared two months later in Keyboard to present MIDI in detail goes out of its way to introduce MIDI as the next logical step of evolution of electroacoustic instruments.[43] Such 'objectivity' is hardly surprising as the article's author is one of the MIDI manufacturers.

For the user, following the trend meant not *upgrading* the older tools, but *retooling* of the compositional environment. "Only a year ago, MIDI was a novel feature found on just a few forward-looking instruments. But today it's become a fact of life. Chances are that if a new electronic instrument doesn't have the MIDI on it, you'll be advised against buying it" (Milano 1984a, 42).[44]

3.4.2.2 Yamaha DX Series of Synthesizers

The original MIDI specification released in August 1983 had a list of 12 manufacturers including Moog, Yamaha, Korg, Roland, Lexicon and Kawai (MIDI 1983, Table 7) who had already received a manufacturer's ID number. Roland and Sequential Circuit MIDI-controllable synthesizers were mentioned earlier. Fairlight presented its CMI MIDI-compatible station at the AES convention in October.

The first review of a MIDI-based instrument found in CMJ is one on the Yamaha DX series of synthesizers.[45] These instruments continued the line of ***digital synthesizers*** started earlier with the GS series but DXs were portable, had MIDI, and had synthesis facilities accessible (although not entirely) to the user. Starting with DX7, data entry on all Yamaha synthesizers was done through LCD display, marking the end of manual connection design. For the first time an instrument of such quality came at the low-end of market price (the DX7 was priced at $1600-$2000, the DX9 at only about $1400).[46] These differences proved crucial for its success.

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[43] Moog 1983, 19.

[44] See Chapter 5.3.5 "Negative Social Effects."

[45] Auspiciously, it follows the presentation of MIDI standard given on the same page.

[46] CMJ immediately pointed that out in its review: "The low cost of these machines compared to that of previous systems makes them especially interesting" (CMJ 7[4], 73). The Keyboard reviewer was equally amazed: "The FM technology used in these [DX] instruments is the same found on Yamaha's GS1 and GS2, and since the DXs are programmable you might expect them to cost even more than the GS1. One of the surprises is that the list prices are $1,995 for the DX7 and $1,395 for the DX9. They're also MIDI-equipped" (Milano et al. 1983, 54).

Thanks to MIDI, sound generation could now be controlled remotely, as could certain parameters of sound synthesis using a voice-editing program on the computer. The DX7's synthesis facilities came with six oscillators that could be used in various groupings choosing from 32 available algorithms. The result was one-voice polyphonic,[47] later expanding to 2 voices in its DX7 Mark II in 1985. At parallel moments to DX7 and DX7II Yamaha introduced TX816 and TX 802 which contained only the synthesis / preset section of the synthesizer mounted in a smaller rack. These were multi-voice units compared to the one-voice capability of the original DX7.

DX7's voicing possibilities in conjunction with the Yamaha music-oriented computer CX5 running a voice-editing software were demonstrated at the same ICMC 84 right after the MIDI Panel. The positive reception of that demonstration contrasted sharply with the critique MIDI had just received. The practicality of using these new affordable tools and dissatisfaction with the standard are major factors in the reception of MIDI.[48]

Technological breakthrough in the design, quality and cost of the DX synthesizers marked the end of the analog era of synthesizers. The new generation of synthesizers was all-digital and MIDI-controlled. Their features "established the credibility of digital rather than analog methods of synthesizer design" (Manning, 295). Within four years after the official announcement of MIDI one can see how this technological revolution unleashes a flood of all-digital MIDI equipment,[49] towards the end of which the music industry is fully supplied not only with the devices but also with supporting parts such as interfaces, connectors, adapters, effect boxes, and so on. It prompted Loy in 1985 and later Moore[50] to recognize that despite numerous flaws of the protocol "MIDI has flourished and it is now the *de facto* industry standard" (Loy, 8).

3.4.2.3 Spread of MIDI Equipment

A good example of the speed of development of MIDI-based devices is a survey of product presentation announcements related to MIDI in Computer Music Journal in 1983 through 1987. Starting with the two announcements appearing in CMJ 7[4] presenting MIDI and Yamaha DX synthesizers their number grows exponentially to the point that MIDI is taken for granted and no longer mentioned in the new announcements.[51]

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[47] Meaning more than one note could be played simultaneously.

[48] Again the affordability of these tools is particularly praised by the reviewer "The impressive point of the demonstration was the timbral quality of the DX7 in relation to its cost (under $1600). [...] A total cost of less than $2000 for both the CX5 and DX7 seems reasonable for every small research and educational center." (Report from ICMC 1984, 31-32).

[49] According to NAMM, more than 220,000 MIDI synthesizers were sold in 1986 in US only, more than three times the number sold in 1983 (CMJ 11[4], 41).

[50] "The Musical Instrument Digital Interface (MIDI) is now a *de facto* standard for the digital representation of musical events" (Moore, 19).

[51] See Appendix C.

The speed of adoption of MIDI in musical products backfired in multiple problems in its implementation: "Problems, incompatibilities, and inconsistencies crop up that were undreamed-of when the specification for the MIDI computer code was written" (Milano 1984a,[52] 42). Describing the reasons for this commotion, Milano concluded: "Consumers have been led to expect miracles from MIDI. [...] Consumers have tapped into the buzz without taking the time to understand what you can and can't do with MIDI. Synthesizers builders [...] had too little time even to gather the information needed to analyze all the problems that have come up, let alone implement the fixes that are needed to guarantee compatibility. [...] The problem is magnified by the fact that no one seems to have had the foresight to hire or assign employees whose job is specifically to monitor MIDI; many just don't have the funds for such luxuries" (Milano 1984a, 42). This situation prompted the spokesman for Yamaha, one of the largest MIDI manufacturers, to recognize that "the technology is going a lot faster than we're able to implement it" (Jim Smerdel in Milano 1984a, 46). Roland's representative interviewed in the same article acknowledges that "... yes, there are still a few bugs in MIDI between manufacturers that are being sorted out" (Jim Mothersbaugh in Milano 1984a, 42).

Lack of communication between MIDI manufacturers greatly attributed to implementation problems. Smith recollects "the 'mono mode' fiasco, in which Yamaha thought that Mono mode was meant to turn a polyphonic instrument into a monophonic instrument, when it was actually meant to allow a single voice per channel. The fix ended up being a new mode just to handle this problem, because there were so damn many DX7s out there" (Smith 1993, 72). The solution to a problem in the previous example clearly demonstrates Yamaha's dominating presence on the market resulting in a direct influence over the protocol development. Carmine Bonanno of Octave Electronics observed the difficulties caused by lack of sufficient information from the angle of a smaller MIDI manufacturer: "The only thing I don't like about it is [...] I think that if they talked to each other more rather than try and hide everything, MIDI would be a lot better off than it is. [...] When we find out that other instruments can't be controlled by ours, we find that it's because the other people changed the spec and didn't tell us. [...] I can't tell you how many people scream at me because DX7s don't respond to some kind of command from early Voyetras" (Carmine Bonanno of Octave Electronics in Milano 1984a, 60).

Despite numerous problems, the MIDI protocol was seen as a permanent fixture on the musical scene by its developers. Dave Smith, interviewed in spring 1984, expressed pessimism about the possibility of changes to the protocol. "MIDI is going to be emerging and growing into more of a standard over the next couple of years. [...] If a couple of people get together, form a committee, and decide to try to change the spec, they'll really be opening a can of worms. Nobody really owns the spec, so it'll become a real mess" (Dave Smith in Milano 1984a, 44). Yamaha's response was in full agreement with Smith's: "I don't feel like we've reached a limit or a real barrier with MIDI at this point. From that standpoint, I don't see any major changes in it for a while" (Jim Smerdel in Milano 1984a, 48).

[52] The entire article, "Turmoil in MIDI land" which appeared in June 1984 issue of *Keyboard*, concentrated on confusion caused by implementation of MIDI by different manufacturers.

In 1984 MIDI ports were added to ***computers*** such as the new user-friendly Apple Macintosh (Mac) and Commodore 64. Apple Macintosh was at the foreground of integrating microcomputers into the MIDI environment. Its emphasis on general user accessibility through the user-friendly interface was similar to the same emphasis in the concept of MIDI. Before the end of 1984 the first MIDI-based music editor software was released for the Mac. "By the time my first article on music software for the Apple Macintosh was printed [Yavelow, 1985], nearly three dozen Macintosh music products had been released. The Macintosh's superior screen graphics, friendly menu-based user interface, expandable random-access memory (RAM -- up to 4 Mb), speedy MC68000 microprocessor, sound-synthesis capabilities, and portability all contribute to make this microcomputer ideal for music applications" (Yavelow 1986, 11). Voice-editing and sequencing were the core of Atari and Yamaha music microcomputers, which would combine FM synthesis with integral implementation of MIDI.

MIDI software falls into several categories: *algorithmic/interactive composition,* often overlapping with *interactive performance* software; *notation; sequencing; voice editing; mixing* and editing for recording purposes; *educational* software. MIDI programs for Macintosh available from Intelligent Music, such as Upbeat, Jam Factory, and M were widely used in electroacoustic music in the second half of the 1980s. These programs combined algorithmic, in particular, pseudo-random approaches, with multi-track sequencing facilities, focusing on interaction and live performance.

Two approaches to notation software coexisted in the 1980s: *graphical object oriented* in which graphically entered symbols on the computer screen create a picture which can be used as a score;[53] and *audio input oriented* which is bound by the limits of traditional notation but facilitated by easy MIDI input and output.[54] SCORE and Nightingale programs have been examples of the first type, the popular Finale program falls into the second category.[55]

With Emulator II, the new generation of ***sampling synthesizers***, digital and MIDI-controllable entered the market in 1984. Its high cost (4-5 times that of DX7) was beaten the same year by Ensoniq Mirage, the first MIDI-based low-cost quality sampler. Digital sampling and additive synthesis (divided in analog and early digital equipment) were combined in digital wave synthesis first available in 1986 in the Kawai K-3.

Drum machines and other MIDI-based ***simulators of acoustic instruments*** became staples of electroacoustic MIDI-based culture. Roland, Alesis, Simmons introduced the first digital generation of drum machines and sensors in 1985. It paved the way for the idea of alternative, non-keyboard controlling of equipment using MIDI. Both Akai and Yamaha introduced their first wind controllers detecting wind and lip pressure and converting it into MIDI values in 1987.

Despite the fact that a significant number of MIDI devices were readily applicable in art music, the development of the MIDI instruments has been directed first and foremost towards the needs

[53] There is no opportunity to interpret the data other than graphically.

[54] This approach allows for multiple-purpose operations of data which includes extraction of score parts.

[55] For more information, see *Beyond MIDI: the Handbook of Musical Codes.*

and demands of a commercial musician. Loy's foresight back in 1985 remains true up to this day: "Unfortunately, it appears that the needs of the research community will continue to be unaddressed in the marketplace. Most MIDI-based computer systems will continue to be directed at standard applications for non-programmers" (Loy, 23). The art musicians had continued to adjust their needs to what is available on the commercial music market.

MIDI has been made to be symbiotic with ***other standards and interfaces***. As early as 1985 MIDI was synchronized with SMPTE, the video standard, which proved indispensable for digital audio recording. In the same year commercial analog-to-MIDI interface allowing the control of MIDI equipment by control voltages was released in Japan. Using FTP (File Protocol Transfer standard) MIDI files started to be distributed over the Internet in the early 1990s.

3.4.2.4 A New Paradigm of the Musical Instrument

In 1985 Max Mathews crystallized the features of "the new kind of musical instrument [that] has been invented" (Foundations of Computer Music, Preface). The MIDI revolution was still underway, but the features of this new, intelligent instrument, developed over the two decades have been solidified in MIDI devices:

- It can synthesize sounds. Theoretically it can make any sound the human ear can hear. It has already achieved sounds of great richness and variety that resemble nothing ever heard before.
- It can sense the intent of the musician. It has a wide variety of sensors [...]. Its sensors will seek out the performer's intent.
- It can execute a program. It includes a stored-program computer. Algorithms that can be programmed are a magic box, the contents of which has no limits except those of the programmer's imagination.
- It can remember. It recalls everything from the score of the music to the gestures of the musician to the sound itself. Memory traces can be recorded, recalled, edited, used by the program, and displayed to the musician (Foundations of Computer Music, Preface).

Expressing the hope that "MIDI will certainly change sometime, or be superseded" (Loy, 20), Loy in 1985 was aware that facing the protocol's success "manufacturers have an understandable unwillingness to fiddle with it. They are unwilling at this time to go beyond ironing out the remaining ambiguities in the standard, and making sure that all vendors' synthesizers will work together under MIDI" (Loy, 19). That has not changed since 1985 when the article was written: certain minor extensions were added and documented in the 1990 MIDI specification text. The protocol proved too inflexible to adjust and has remained unchanged up to this day.

3.4.2.5 MIDI Protocol Extensions

With the creation of IMA and MMA (MIDI Manufacturers Association) as well as JMSC (Japan MIDI Standards Committee), the process of developing extensions to the unchangeable protocol

(much like Amendments to the Constitution) become streamlined (Rona, 15). Among the extensions are MIDI File Standard (MFS) for software transfer of sequence data introduced in 1986 and shared by most of MIDI software companies; appearing the same year MIDI Sample Dump Standard (MSDS) introduced Universal System Exclusive (USE) messages for better data transfer and notification of its receipt; MIDI Time Code standard (MTC) available only within USE made possible synchronization with SMPTE; MIDI Show Control (MSC) also related to USE for controlling lighting equipment; MIDI Machine Control (MMC), another USE-based protocol for controlling recording equipment; and General MIDI (GM) assigning MIDI presets a number from its list of 128 acoustic instruments. Rumors of a coming MIDI 2.0 have not come true.

Chapter 4

Reception of MIDI in Art Music

4.1 Incompatibility of Pre-MIDI Composition Tools

Only about one third (16 composers of 44 who answered this question)[56] reported problems arising from incompatibility of pre-MIDI hardware. General lack of communication and control between the devices is cited in the following examples:

> "Since all of this stuff (the subject's compositional techniques) always dealt with producing sound realtime, you can imagine it was a very non-uniform world there, there was no ultimate music workstation. [You had to] use a lot of different programs on different equipment some optimized for one thing, some optimized for another. So, incompatibility wasn't even a question, because some of the combinations of this gizmo/that gizmo hadn't been thought of. [...] All of those things used different approaches, all requiring exploration with the equipment" (13:*C325).

> "Analog hardware incompatibility was the order of the day. If you changed hardware all the software changed too. At this point I can change the hardware without changing the software" (15:*B190).

Incompatibility of voltage-controlled synthesizers is mentioned most often. There were two limited compatibility models before MIDI. The *single manufacturer compatibility* existed between various devices of the same brand. As such it was implemented by Fairlight, Rhodes and several other manufacturers. Several manufacturers including Oberheim and Roland developed internal protocol for some of their equipment. Others added compatible features limited to some cooperating brands, for example Syntauri allowed its Metatrak sequencer to be synchronized with Oberheim and Linn drum machines.

There also was a possibility of *custom-built compatibility* between different brands based on the same voltage control. Bernardini even elevates that to the notion of a standard: "... compare MIDI to the previous, much more standardized electronic music standard, the 1 V/octave voltage control for modular analog synthesizers. The 1 V/octave was a simple de facto standard created by small artisans at a time in which electronic instruments were not suitable for mass marketing,

[56] Table 2.

and was extremely useful in truly musical ways (e.g., the old Buchla and Serge modular synthesizers)" (Bernardini 1987, 10). Although most pre-MIDI synthesizers used the relationship of 1 volt per octave to set the pitch of the oscillators, it was not a standard since many brands used other voltage values to control envelope generators. Interconnection done by using patchcord connections had to be custom-built. Computers and anything digital were excluded from the environment, unless a DAC/ADC connections were custom-built into the system. As Darter pointed out in 1983, differences in the layout of instruments and function blocked many of these attempts: "Since synthesizers operate using different internal designs -- some have switch triggers, some have voltage triggers, and voltage triggers differ as well -- this {making synthesizers compatible} is sometimes easier to wish than to do" (Darter, 58).

The results of such connection could be hard to predict and manipulate. "One of the most serious deficiencies of existing systems was the lack of any consistency between the control voltage functions used by one manufacturer and those of any other. Attaching a Buchla keyboard to a Moog synthesizer, for example, would result in some quite bizarre results as a result of their different voltage-to-pitch laws" (Manning, 274). The experiences of our interviewees illustrate these problems:

> "I was using a lot of Buchla equipment in the same way I used Moog equipment, they couldn't talk to each other. Moogs have great filters, you can always change the audio signals but not control voltages or triggers. They were really highly incompatible except for exchanging audio signals which is only part of what you want to do" (2:*B535).

As a result, desirable facilities featured in the existing synthesizers could not be added together to facilitate compositional process. "Without a satisfactory way to connect synthesizers of different manufacturers, there was no practical way to integrate the strengths of one synthesizer with the strengths of the other synthesizers in the studio or on-stage. Setups involving several instruments could be very difficult to manage" (Pellman, 264).

Quasi-standard conditions existed in the pre-MIDI computer studios that used similar environments. That would help achieve limited compatibility within the same setup at those particular studios. Respondent #7 points out three of those template setups:

> "What's important also in non-real time music was in the early days there were three, maybe, kinds of studios: there were copies of Stanford, copies of MIT and copies of Princeton. Some studios like Colgate and IRCAM just got a PDP10 and were exactly just like Stanford, other ones got a PDP11 and MUSIC 11, like Eastman and Salzburg and were copies of MIT; and some other places had IBM mainframes, like Princeton, got MIX and MUSIC 4BF. You could move among Stanford studios, for example, and take your tape and take your SAIL program, so I worked at Stanford and at Colgate and at IRCAM in the late 70s and as long as I went to those copies of Stanford I could take tapes [from] both programs and digital sound around"(7:*B110).

The first MIDI years when pre-MIDI and MIDI tools coexisted saw the continuation of the old problems. MIDI devices were certainly compatible between themselves, but not with the pre-MIDI analog and digital equipment which was still in wide use.

"I remember having to deal with liking the Buchla patch languages that I was using but being frustrated because there were only 12 oscillators. I wanted to be able to interface that to DX7 and the first E-MU samplers, that was fairly problematic. I had to go to Jay Cooper and I ask him to modify a control voltage to MIDI converter and I used it to some extent but it seemed fairly flaky. Also that time I started to have opportunities to get my pieces played in lots of place and I started to think about 'Well, I can't just send this Buchla around. It would be great if I did write a piece for a kind of a standard set of instrumentation [...] and using standard MIDI formats' (18:*A210).

Not only non-MIDI hardware, but also non-MIDI software had to be adapted to new MIDI hardware.

"When MIDI came out, we adopted MASC [software] so it would run on MIDI instruments. We created a function called note-on, a function called note-off, all of the things that are parts of standard MIDI spec we then had words for in MASC. They [MIDI ports] were [then] built into the computer" (29:*A420).

	Yes	No
Experienced problems due to incompatibility of the pre-MIDI hardware	16	28
Percentage 1	36	67
Attempted to connect incompatible elements of the pre-MIDI setup	6	29
Percentage 2	17	83
Developed elements of the pre-MIDI setup later replaced with the MIDI ones	14	28
Percentage 3	33	67

Table 2. ***Pre-MIDI Incompatibility***

In facing the compatibility problems, some composers (17%) attempted to forcefully connect incompatible elements of pre-MIDI setups.[57] Artists with an engineering background fared better than others in designing and building missing connections.

"I built the hardware myself. I built my own interfaces. I would mount them in my own racks. I was always involved in making instruments, so that was a natural thing for me to get interested in. For example, if I'd built a filter circuit and I wanted to control with the SERGE low frequency oscillator, I would just study the specifications of their voltages

[57] Table 2.

and make some adjustments to connect them to each other. [...] It was all always about making incompatible things compatible, I was always faced with that but that's where I worked" (40:*A360).

It does not come as a surprise that a composer with a strong engineering background who acknowledged incompatibility never considered it an obstacle.

"[Incompatibility] Before MIDI? Not so much. Most of [the tools] were custom-made, it was about simple things like getting voltage levels to be compatible which is not hard to do with some simple circuitry.[...] For instance, to be able to cross-patch instruments you might need to create some simple interface circuit to make them compatible. I never found that a problem because I built a lot of electronics. [..] I built a lot of interface circuitry for the "XXX" piece, in order to let the instrument be controlled by something other than a keyboard" (43:*B330).

All reported examples demonstrate solutions to overcoming differences in voltage control between analog synthesizers.

"I was using the computer as a control device for everything. On the analog systems via voltage control you could control everything: you could control pitch, loudness, modulation index, filter cutoff, speed of sequencer doing something. You do that by just jamming the patchcord into the control input. Normally those patchcords came from some sort of function generator built into the instrument. Instead of using those function generators because what they could do was so limited, you could have 3-4 per envelope and that's as far as it went, now we had a computer that could generate a million point envelope. It could exceed the speed of the analog control" (9:*A340).

"I had some limitations. One of them is [it's] very difficult to change sound color. [-You mean filters?] -Yes, filters on the same synthesizer. I was also using the tape recorder, I had to change many parameters, so it was a big problem. Sometimes I made a kind of control by using CDS panel [which would] change the control voltage by using light. I can control many control voltage events by using light" (10:*A115).

It is interesting to see how the MIDI standard or MIDI-based equipment were foretold in home-made inventions developed in response to imperfection of contemporary technology. Table 2 shows that nearly one third of the surveyed population (14 composers) reported developing their own devices which were later replaced by the MIDI tools. In all of those cases one can see how demand for interaction while working with real-time equipment necessitated the search for the tools which intuitively mirror the ones MIDI technology provided later in the 80s. In all but three cases composers who came up with their own tools were the ones who wrote live interactive music before MIDI. There is a direct correlation between their use of synthesizers (the primary tools for live interaction before MIDI), dissatisfaction with available technology and their development of original elements for the real-time compositional setup.

"I tried to control voltage between synthesizers sometimes. We had a converter which transferred linear into logarithmic voltage. It was terrible to adjust. We had a sequencer, for instance, we could record control voltages from the synthesizer and then replay them. it was very hard to control between -- yes, the norms were different between Roland and Yamaha..."(9:*B489)

'Quasi-MIDI' controlling systems are evident in these pre-MIDI setups:

> "Most of the live stuff I was working with pre-MIDI was interactive electronics which was extremely cumbersome to deal with, if you can even imagine doing that with control voltages. In order to, for instance, take a single set of controls from any number of devices, you had to make each one become a different pitch. Each pitch would go through a filter, and a filter would then go to an envelope follower, so that the signal would be divided up through this narrow filter band and each of the frequencies would go to a separate envelope follower, so that you could separate the voltages, so that you could, say, from one band of tape, you could get several devices simultaneously - you can imagine how complicated that was. The analogy to that [in] what we do now is a single cable with a MIDI signal, you have 16 channels. [Before MIDI] I was dealing with channelizing voltage, but the only way I could do it was convert it into frequencies and isolate the frequencies and then convert them back into voltages. That's so cumbersome, only a few of us even attempted to do anything like that. Now I replaced all of that with MIDI" (21:*B228).

> "All the robots [automated music sculptures used in performance in '81] had their own voices. Those voices were actually on cassettes and somebody was actually playing a keyboard that just triggered the cassettes to play further. I think he had eight buttons, but if he let one talk too long, the start point would be lost. If you think about it how we did, it's just so crazy with these 8 cassettes and this guy sweating every evening to do the synchronization of voices right" (23:*A300).

The examples above demonstrate the need for multi-channel controls later incorporated into the design of MIDI. In the following example, a drum controller is designed to control voltage predicting development of MIDI drum controllers.

> "We did things with control-voltage using practice pads with contacts mikes on them, we were working with that because we wanted percussion controlling. Pretty soon ... drum and things like that came out and they were MIDI percussion controllers and those things became standards" (18:*B420).

Another typical group of elements of MIDI setup presaged in pre-MIDI years were those responsible for ***analog-to-digital*** and ***digital-to-analog conversion.*** They had been an essential part of many interactive environments and later were replaced with the similar MIDI devices, for example a MIDI pitch tracker.

> "It was all home-made. I made it myself, all the connections were custom. There were no connections at that point, I was making these things before MIDI came along. So I built my own digital-to-analog converting interface to the microcomputer. I was using a fairly small Rockwell AIM 6502 microcomputer" (40:*A130).

Computer software was used as the direct controlling medium in the following case involving two pre-MIDI digital elements of the setup.

> "I had designed a couple of HMSL programs. HMSL is a software running on a MCA, Amiga. In this case it was driving a Kurzweil [sampler], choosing voices from the Kurzweil. That was back in early '82" (41:*A155).

When MIDI tools became available, the same composer replaced the original sampler with a MIDI one.

There is a classic example of several computers networking during a live performance described in fall 1978 issue of CMJ. All three KIM microcomputers had different programs but through the use of the same kind of I/O, composers were able to receive and send out musical digital data. All connections were in a one-way circle (A->B->C->A). The output of each computer was sent through DAC, mixed in the same mixer and amplified (Bischoff, Gold, Horton, 24). This example shows the interest in control of the flow of digital data based on the same nature of tools. However, since the remote editing of data (on another computer) was not possible, the control capabilities of communication and editing of the flow of digital data were limited in their control parameters.

The quality of the coming MIDI replacement was not always able to match that of the original non-MIDI tool.

> "I used ADCs from drum triggers. Once real drum-triggers that were MIDI came along, it was just a lot easier to deal with, I could get not only triggers but also velocity, really precisely scaled. At a certain time I was using a regular acoustic piano both for triggering things and for generating sounds with the Buchla system. Even though we got a much more precise control of computers over MIDI equipment, what I lost was nice acoustical warm quality and also availability to amaze the ear in real-time transformations of sound that were coming out of piano and would be influenced by other processes" (18:*B385).

Another composer (#8) created a fully controllable 'quasi-MIDI' environment which included a modified piano controlled by computer ZYLOG-90, which was sending out files, similar to MIDI files, to the piano but at a better rate.

Certain elements of the non-real-time pre-MIDI setup were replaced by MIDI tools as well. A MIDI synthesizer would replace an analog one (#39) and available MIDI tools substitute for pre-MIDI software.

> "I was writing software to do software synthesis. I stopped doing that, I got enough MIDI tools together to do things there. I'm no longer writing software to synthesize the sound" (34:*B380).

With the composers who never used MIDI, it is obvious there is no substitution of elements. "I still use the tools I developed earlier, leaving aside programs that no longer run" (12:*add3). Another composer who was disappointed by the MIDI tools and never used them for writing a piece, chose to explore analog domain in more depth. This 'reversed' move is specifically present in only one case.

> "My solution was to go backwards [rather] than to go forward. I couldn't get what I wanted out of a Yamaha synthesizer, so I used it as a sound source. And to get what I wanted I could've used the old analog equipment. Maybe this is just nuts to go backwards but I found it useful. I don't care, I'm pragmatic, whatever works I go with it. I'd use the Synclavier as a sound source, then put it on tape and then play the tape

recorder and process that sound -- send it through a whole frequency shifter, or an old filter" (16:*B205).

Although the range of solutions to compatibility problems is impressive, the majority of respondents, nearly two-thirds, did not experience compatibility problems in the pre-MIDI days.[58] This majority directly reflects the majority of composers who worked with non-real-time computer vs. real-time synthesizer music before MIDI. These composers were often lucky to avoid thinking about these problems working in an environment, usually an electroacoustic college studio where all elements were fully compatible.

"I didn't think about it. We had our own world here and it was very homogeneous, much more than it is now. We had the Samson Box and there was the whole culture around the Samson Box. Everyone wrote for it, everybody exchanged software, everything was standard, we never went outside of CCRMA" (32:*B380).

It was especially convenient for software synthesis-based non-real time composition which usually bypassed external synthesizers.

"No, I was working with non-real-time computer music systems like Music 4, 10, etc. It was a pleasure to have nearly perfect compatibility with these kinds of languages. But we weren't doing live performance with them" (44:*add3).

In cases when incompatibility was an issue, a typical way of dealing with it was to **avoid using mutually unacceptable hardware:**

"We had some Moog envelope followers and I don't even remember using voltages. The voltage for Buchla was different than the others, I'd never try to use Buchla control voltages to control the Moog module" (28:*A405).

"No, I didn't [have compatibility problems]. I always had this consort of the like instruments. First of all built my own, second of all we were given these Synthi AKS's, and then my association with Buchla, we had all these Buchla instruments" (29:*C335).

"I didn't experience that [incompatibility] but my situation was pretty simple. I avoided getting in that situation because I knew that hardware developed for system X would only work for system X. I knew that was a problem but that was not a problem that affected me because I was avoiding it" (25:*A590).

"Each piece was made in a special environment, I'd use one studio and the same one from the beginning to the end of the piece so I could choose what I could use in the studio" (22:*B330).

[58] Table 2.

4.2 Anticipation of MIDI

79% of those who answered the question "*Did you expect the appearance of a control standard like MIDI in the mid-1980s?*" responded negatively.[59] The *surprise* pattern dominated the answers. "It was a surprise!" (42:*A284) At the time of their introduction to MIDI the majority of composers interviewed in this project worked in studio environments where the setup usually eliminated or minimized the problem of incompatibility. Very few composers worked independently.

	Yes	No
Expected appearance of an interconnection standard like MIDI in the mid-1980s	8	31
Percentage	21	79

Table 3. ***Anticipation of MIDI***

MIDI functioning as a communication link between commercial synthesizers caused little interest among composers not using those instruments."[Did you expect the appearance of a standard like MIDI in the mid-1980s? (yes/no, please explain)] -No. Just wasn't thinking commercially at the time. MIDI was a response to a commercial need, not a technical need" (30:*add5).

Several composers expressed frustration with the lack of involvement on the part of the art music community in the development of a standard likely to affect the tools by which this community exists. The community was neither consulted, nor collaborated with on the development of the standard.

> "I don't think any of us really expected it. I think what happened was it came up too quick, too soon. When we saw it being pushed out of the door, all of us said 'This is great, but stop! Stop now, so that we can make sure it's been built properly, so that we don't standardize the interface that isn't going to be usable for what we need" (14:*A250).

> "There was no monumental conception. [..] It's just evolved like everything else, largely driven by commerce, had nothing to do with what we thought (academic, art musicians) it should be, it did not develop like that at all. It was a surprise! It had nothing to do with our world, it had all to do with the world of commercial music" (42:*A284).

If anticipated, such a standard was expected to come from within the community, from one of its research centers, as shown here:

> "I guess I was surprised that it came from the industry. We had been discussing in the computer music world and there was already some kind of standardization but I didn't expect it would come so quickly and, in some sense, be so good. [...] I didn't really expect that it would come out mostly from the industry. I didn't expect it would happen in this way. I would have expected it might have come from a place like here {IRCAM}, not only IRCAM but collaboration between IRCAM and other centers. Although IRCAM at that

[59] Table 3.

time was very intent in its individuality and specifics, other centers were more willing to cooperate" (38:*B515).

A source writing from the standpoint of commercial music recognizes the search for compatibility.[60] "After some initial, independent attempts by individuals to customize their equipment to this end, an appeal was made to the synthesizer manufacturers to establish and standardize a protocol (operating methodology) for computer music communications which could be followed by all manufacturers in the design of various pieces of equipment" (Winsor, 23). However, judging from the low percentage of art composers who experienced problems with their pre-MIDI equipment and anticipated a compatibility standard to come, the author's conclusion about the 'appeal' does not hold ground in art music.

Some composers contemplated the existence of a standard but not for a serial standard for digital control. Those ideas varied from an analog instrument standard (4:*B510) to the software transfer standard. "[Were you looking for compatibility at that time MIDI arrived?] -I don't think so. I was looking for compatibility of language, not compatibility of instruments" (29:*B80). "That {compatibility of software} was a real problem, how to transport a program you wrote in Pascal to C, or another language, this was a real problem, it's not solved still there" (44:*A265).

It is hardly surprising to expect a major development in these particular areas considering that analog synthesizing units and software-based composition played the dominant role in this kind of music in the early 80s.

Ideas for a different standard and skepticism about the extent to which art composers could have contributed to the development of a protocol primarily geared towards commercial equipment are evident in the following excerpt:

> "Had I been asked at that time what sort of real-time performance system I would imagine, I would have imagined something very different, [..] Samson box kind of power and real-time control which would've been broad-bandwidth, lots of depth. But of course, it would not have been a commercial product, because it couldn't have been. [...] Because of the nature of commerce, the cost of products to get out to the hands of consumers is the limiting factor. No matter what anyone could or would have asked for back then, it probably couldn't have been any different than what it was simply because they had to have serial communication because of the cost of parallel communication. The intrinsic complexity of parallelism vs. serialism: one wire in sequential bits, rather than parallel bits. Our world was one of lots of parallelism and lots of depth and depth and the MIDI world had to be what it was. So, my view is no matter what input we might have made, had we been asked, it would not have made so much difference. Maybe little difference but not much, may be system exclusive, the equivalent, at the very beginning would have been the most they could have managed. In fact, it may be that system exclusive opening up the machines was the only thing that resulted from computer music world as an effect" (42:*A354).

[60] Evident in some examples in Chapter 4.1 "Incompatibility of Pre-MIDI Composition Tools."

The remaining 8 composers, about one fifth of the composers who answered this question, anticipated the coming of a digital standard. Rapid progress of digital technology, centered around microcomputer revolution triggered such expectations.

> "Yes I think so, I think I did [expect the appearance of a standard like MIDI]. It was clear that the personal computer revolution was getting to be big enough that the standardization was inevitable because people would see where that would take them. And there are certain real advantages to standardization too. That there would be a musical counterpart to standardization, that that was going to happen, seemed to me obvious" (43:*B250).

> "[Around 83-84] it became very clear to us that the digital world was approaching and that there were going to be all sorts of control possibilities and greater possibilities with computers and samplers were going to emerge mid-to-late 80s" (11:*A290).

The experience of working with synthesizers, the lack of which minimized anticipation in the negative response category, boosted expectations here:

> "In retrospect, I think I saw it coming, that there was going to be a way to communicate with synthesizers. Certainly the development of FM had a lot to do with it" (24:*A540).

> "There had already been almost 10 years of completely non-compatible systems, or 6, or 7 years... [In] mid-70s you have Alpha-Centauri, you have Fender-Roads, Chroma, there were a bunch of computer musical instruments that were not standardized. As soon as I heard somebody's working on a standard so all these can talk, it seemed obvious" (7:*A530).

4.3 Introduction to MIDI

MIDI and its foremost carrier, Yamaha DX7, were introduced nearly simultaneously in different parts of the world. Even though manufacturers of Yamaha and other early MIDI synthesizers were predominantly based in Japan with some technology originating in California, the survey shows no correlation between the locale of the respondent and the time of introduction. There was no delay: the information about MIDI was dispersed evenly across the world. The conducted interviews contain citations of the DX7 dating back to 1984-1985 in places as distant as Marseilles, France, and Buenos Aires, Argentina. The Paris location of ICMC where both MIDI and Yamaha DX instruments were presented in 1984 also helped to instantly extend information beyond Japan and the US. At least 12 respondents reported ICMC in Paris in 1984 as the place of their introduction to MIDI.

82% of the surveyed composers were introduced to MIDI in 1983-84, within 18 months of the first official presentation of MIDI[61]. If we add those who were introduced to MIDI in 1985, the percentage grows to 91%.[62] Even considering an error margin of 10-15%, these results suggest that the majority of the composers working in the field became aware of MIDI and MIDI devices within the first 2 years of its existence.

[61] January 1983, NAMM.

[62] Table 4.

	"83 -84	'85	'86	'87	'88	'89	'90	'91	"92 -96	never used	n/a
Year of introduction to MIDI	37	4	2	0	1	1	0	0	0	0	0
Percentage 1	82	9	5	0	2	2	0	0	0	0	0
Year of the first piece with MIDI	8	7	3	5	4	4	1	5	1	4	3
Percentage 2.1 (of all available answers)	19	16	7	12	10	10	2	12	2	10	0
Percentage 2.2 (among those who used MIDI)	21	18	8	13	11	11	3	13	3	0	0
Percentage 2.3 (of the total population)	18	15	7	11	9	9	2	11	2	9	7

Table 4. ***Introduction to MIDI***

Table 4 also shows that only 19% of the composers (or 21% of those who composed with MIDI) wrote pieces involving MIDI equipment in 1983-84. Compared to 82% who were introduced to it, it brings about questions about the dynamics of conversion to the use of MIDI tools. Even though there is a larger influx in the beginning - by the end of 1985, the total number of composers using MIDI in composition goes up only to 35%. After that the technological conversion flow continues to rise steadily throughout the end of the 80s and the beginning of the 1990s averaging 7% per year. By the end of 1986 91% are introduced to MIDI and it can be concluded that the information has been successfully dispersed. Yet only 42% have attempted writing music with MIDI tools. As one can see, only in the beginning of 1990s does application of MIDI tools finally catch up with their introduction.

Although MIDI tools were available on the market, it took a longer time for them to reach electroacoustic music studios where the majority of composers were centered. That and the stylistic reasons discussed in Chapter 6 were factors in slowing down the process of adaptation to the MIDI equipment. Several composers rejected those tools until MAX software featuring a higher level of interaction between computer-generated timbres and real-time manipulation became available.

4.4 Reception of MIDI

The confusion which accompanied the reception of MIDI was vividly present in the article "Turmoil in the MIDI land" which appeared in the June 1984 issue of Keyboard. "Problems, incompatibilities, and inconsistencies crop up that were undreamed-of when the specification for the MIDI computer code was written" (Milano 1984a, 42). Describing the reasons which led to it, Milano concludes: "Consumers have been led to expect miracles form MIDI. [...] Consumers have tapped into the buzz without taking the time to understand what you can and can't do with MIDI. Synthesizers builders [...] had too little time even to gather the information needed to analyze all the problems that have come up, let alone implement the fixes that are needed to guarantee compatibility. [...] The problem is magnified by the fact that no one seems to have had the foresight to hire or assign employees whose job is specifically to monitor MIDI; many just don't have the funds for such luxuries" (Milano 1984a, 42). "It seems that the technology is going a lot faster than we're able to implement it" (Jim Smerdel in Milano 1984a, 46).

Initial reaction to MIDI and MIDI equipment among art composers can be divided into 2 roughly equal groups: 21 interviewees responded positively, showing interest and approval of the new technology; for remaining 24, the downsides of this technology prevailed in their initial opinion.[63]

	Positive	Negative
Initial reaction to MIDI	24	21
Percentage	53	47

Table 5. ***Initial Reaction to MIDI***

The speed at which the composer adapted to new tools depended on how quickly the coming MIDI gear answered his/her compositional needs.

> "For me it was really interesting because of precise control of time, the ability to edit, the ability to move musical materials as blocks, to use cut and paste technology in the composition - it was something I had been interested in having as a concept and was glad to be able to do that" (25:*A578).
>
> "I didn't find MIDI very exciting until MAX came in 1989. At that time the programs were very simple and you didn't have the access to the sound files" (02:*A415).
>
> "Because I was doing things which were so close to what MIDI did before MIDI came, to me it was just an extension seeing how easy it was to use. For composers who were doing other things, for instance, doing only tape music, this would've been a challenge to figure out exactly whether they wanted to do it or not, for me it wasn't a case" (21:*A485).
>
> "[I was] seeing that MIDI was quickly becoming a lot more powerful than what it initially seemed to be, was more than just connecting keyboards to different tone generators, I

[63] Table 5.

> could send out some floppy disks with the samples on them or there's ways of actually moving data around, moving sounds around cross-platform. By the time it all became apparent, then it seemed this is the correct tool to be using. [It] would let me make a piece more generally performable and it was simply a standard that was being embraced. Despite its perceivable limitations even then, it seemed like more potential was [coming] on than the limitations" (18:*A230).

This is contrary to the experience of #15, who embraced MIDI tools as soon as they appeared on the market. It is important to note the connection the interviewee made between the applications of new equipment to his compositional interests.

> "What was around in 1983-84 for making real-time interactive music? What could you buy to do that? The answer is nothing. Other than Apple II and some 8-bit based computer, may be you could cut around PDP11 [...] From my standpoint, it was necessary for me, as an *itinerary [-based]*, as opposed to an *institutionally-based* musician, to have a flexible and portable setup, the one you can take virtually anywhere, not when you need a truck and resources of a university to get going. Also if we look at the resources available at the universities at that point, none of those were devoted to live performance anyway" (15:*A200).

The more relevant the new tools were to the compositional interest, the more positive the initiation to their use was. As observed by Loy, a contemporary to the events: "Whether MIDI gets good or bad reviews depends to some extent on whether it represents a step up or down in expressive potential from the system the reviewer is currently using" (Loy 1985, 8).

The novelty of new sounds and new paradigms for working with tools attracted the interest of several composers to MIDI equipment.

> "In some respect I was a little bit influenced by the freshness of it {Yamaha DX7} in the beginning. It was something different, it would still have a certain warmth to it that I think some of the earlier synthesizers had, warmth of sound, ... colorwise" (37:*A475).

The initial impression of MIDI was often laid against the background of the long-term experience of working with pre-MIDI electroacoustic music, in particular, its achievements. What MIDI equipment could not do, but the analog or pre-MIDI digital could, was often the main source of hesitation for using it.

> "[With MIDI] it's very easy to produce a lot of notes, but it's harder to have refined control over the notes in MIDI than that it is using something like MUSIC 5 or software synthesis. It doesn't mean it's impossible. Especially in the beginning it was harder [...]. MIDI synthesizers didn't allow as much control over the sound, over the data stream. You can set the voice and those become qualities of the voice which are not adjustable remotely. There are MIDI controllers and such, but early synthesizers did not allow all that much to be controlled by MIDI controllers" (32:*A290).

> "It {MIDI} seemed quite obscure, that may be in part in the way we interacted with it using its own onboard editing environment and it seemed quite obscure and quite unnatural after thinking analog synthesizers. Not that I ever used synthesized analog sound, but just on the front plate of the AKS, you had a little patchbay there and any input could go into any output, it had no mistakes you couldn't patch anything wrong.

> Just the very whole open thing [before], everything was there, seemed much more natural" (11:*A580).
>
> "One of the characteristics of my tape pieces was always processed sound. That's the first thing I tried to do when I got MIDI. The main inspiration to use MIDI in [his first MIDI piece] was to use processed sound" (31:*A415).

If MIDI features were of no interest to the composer, the reaction to the equipment was indifference. "The compatibility of instruments didn't interest me. It wasn't the question of what wasn't there, it was the question that I wasn't there, I was somewhere else" (12:*A381).

In some cases the limitations of MIDI and satisfaction of working with non-MIDI environments led to the total exclusion of MIDI from the compositional setup.

> "I don't have anything against it in principle. [...] It's just that none of the compositional ideas that I've developed over the last 20-25 years, none of them are thinkable in it. So why would I be interested?" (26:*A170)
>
> "Things that synthesizers at that time could do didn't interest me. There was a real strict piano orientation from my point of view, like the note-on, note-off stuff, and the notion of various restricted sets of pitches at your disposal. I can't remember all the details now. I figured something better was going to come along eventually. It hasn't yet but it will" (12:*A332).
>
> "Why MIDI is not appealing to me is because the instrument that is driving it is too much like a "normal instrument". I really liked the sort of abstract aspect working at a computer where you're no longer being channeled into notions of piano, or a cello, or a flute. You don't even have to think in those terms. You're thinking in completely different terms. When I started using the computer it was like a feeling of complete liberation, finally I could think in an entirely different manner. So, MIDI, in that sense was then a return to something like a string quartet to which my immediate reaction was 'Well, I don't write a string quartet. Why involve with the computer to begin with?'" (12:*A450)

The initial reaction also depended on how the standard fulfilled the expectations of a composer for what a standard of this kind should do.

> "In '85, I think, a lot of us were saying 'This can't become a standard'. The way that it is, we realized, what the problems were going to be where the communication were concerned: it was too low bandwidth; it didn't take a lot of things into consideration, you're going to standardize an interface to a keyboard that was going to be manufactured by the manufacturer, you're going to put a standard out there that if it wasn't a standard, in a couple of years would probably be 50-60 times better than it is" (14:*A270).
>
> "I thought it {MIDI} was pretty bad, very limited. [...] The speed; the number of channels; the length of cables; the fact that it wasn't a real network; it was only point-to-point; the fact it had no time-stamping; it wasn't a real network protocol -- lots of problems" (07:*A550).

These opinions show the clash between the demands of art composers[64] and the introduced standard. Explaining the reasons for staying away from MIDI equipment for years in the situation of easy access to them, #02 says:

[64] See Chapter 3.3 "Demands of Electroacoustic Art Music in the First Half of the 1980s."

"The DX7 was a poor implementation of FM. This is the way we felt at that time. We knew FM inside out, the FM theory. We were able to understand the C-ratio and all that, and make complex sounds. With the DX7 you didn't have any of such fine control. The way FM was implemented [in the DX7] did not seem to us satisfying compared to what we had access to. The only interest was real-time, but we didn't have any use for that. So, when it came to algorithms and synthesis algorithms, our tools were much, much better...much more flexible, much more controllable, much more predictable"(02:*B350).

Or as #27 concisely answered the question about the relation of MIDI to what he was doing in early 80s: "It didn't seem to have any connection" (27:*B125).

In the case of #38 one can see the trend to use new MIDI tools as an *extension* of an already developed non-real-time computer music system, a pattern quite typical of composers who have synthesis-oriented software.

"For me it was not a drastic change. Although we followed rather closely both what was happening around and [...] we worked to see what it could do. I was not personally so much interested except for one application which we put into work shortly after MIDI came - when you do synthesis of some phrase which sounds like a musical instrument, you are responsible for performance anyhow, if you want to [give] it suppleness, phrasing etc.. The composer [who] will write a program for synthesis must incorporate this suppleness, this expressivity of performance into music. [..] So one obvious way to do is to perform a phrase, for example on a keyboard, I guess that's the basic MIDI input [...]. We did work with a music student [...], he did a MIDI-to-MUSIC5 converter. That was a kind of sequencer that would record MIDI performance and then would transcribe it into the format for MUSIC5... " (38:*B120).

For a lot of composers introduction to MIDI was inseparable from introduction to Yamaha DX7.

"We {composers of that time} were into very fine control of sound synthesis and of sound processing. When MIDI came, it came through the DX7: for us, MIDI and DX7 were the same thing, MIDI was the way of controlling the DX7" (02:*B350). "I can't separate my initial impression of MIDI from my initial impressions of DX7 and voicing that came along with that. We had obviously some very impressive moments when there was this portable keyboard creating simulations of acoustic instruments that'd been so nicely voiced, that it was quite a rival to anything coming out of the big mainframe computers around the same time. As a by-product it happened to have that MIDI jack I didn't understand much about at that point but I was thoroughly intrigued by the synthesizer" (13:*A15).

In fact, 19 out of 45 composers mentioned Yamaha DX7 answering the question of the time and place of their introduction to MIDI. Surprisingly, they mentioned this connection without being prompted to recall any such link.[65] If that had been a separate question, this number would probably be even higher, but as such already demonstrates the deep connection between introduction of both MIDI and Yamaha DX synthesizers in the communal memory.

[65] There was no question in the questionnaire about the DX7 proper.

"I don't really remember. It's sort of confused for me with hearing about DX" (28:*A486).

"It [initial impression of MIDI] was a little confused by the fact that I think I saw or probably I heard the first DX7 earlier and the first DX7 was MIDI but it's not the fact it was MIDI. I was very impressed, fascinated by the fact that you could put into a commercial instrument that was relatively inexpensive and small all these timbral possibilities. So I guess my first impression was rather strong and then when I realized with MIDI you could do lots of combinations of this kind of means I was very impressed. [..] When it came it had MIDI so I sort of confused the issues at some point" (38:B550).

As it can be seen from the survey of pre-MIDI equipment, some features of its design had been available before and as such had been received and accepted/rejected by the composers before the actual coming of MIDI.

"Synthesizers were already keyboard-centric, look at the Moog, ARP, Synclavier, Fairlight, even pre-MIDI they were all keyboard-centric. Mini Moog already had fixed pitch and then pitch bend. The market already had this completely keyboard-centric approach." (07:*A565)

"The behavior [of an early Casio MIDI synthesizer] was very much like the analog synthesizers I had been working before. It was not, for example, FM which would have been totally different. This particular synthesizer behaved in very much the same way as the analog synthesizer from the user's point of view but internally it was completely digital" (33:*A510).

However, when first MIDI equipment offered a combination of the quality synthesis, with keyboard features and advanced control possibilities,[66] it could reignite interest in keyboard synthesizers among composers who had not used or stopped using it before. "I wasn't interested in what was happening in the commercial type world until I found out about DX7 and the fact that you can get mainframe power licensed, harnessed and made available in a relatively inexpensive real-time system" (18:*A200).

The expansion of new MIDI-based computer-oriented technology did not advance at the same pace for different kinds of tools. For awhile, analog and digital equipment, powerful or less developed tools were often combined in the same setup.

"I think things might have happened differently if there'd been wonderfully powerful machines, the kind we have now, but we didn't have those. MIDI was designed to work with slow cheap machines like the ones that were available to most people. And those were the ones that if anyone was using in live music, those were the ones they were using and everyone else put things on tape. That was the state of the art in '83-84" (15:*A235).

Getting to know MIDI tools became the process of separation of what was useful or worth experimenting with from the elements that did not correlate to the compositional demands.

"The first MIDI type drum controllers or mallet type of controllers were a huge step forward. Starting to get instrumental gestural descriptions from MIDI keyboards and MIDI mallet was a big step forward. The precision of highly accurate notes rather than

[66] compared to previously existing analog and digital tools.

inferred notes, being able to MIDI keyboards and mallets gave me a lot more input. I found, however, I was never terribly excited by the tone generators and samplers, [meaning] presets and editable sounds" (18:*A300).

"I was in MIT when I first started using it and I wanted the computer to follow this, to play notes and to do all these various things and to be able to make lights and all that stuff. I couldn't do it. It was very clear to me that things like sequencers, modules like that attached to the computer would be very useful, so I used them almost from the very beginning" (21:*A470).

Meanwhile composition tools themselves did not stay the same; the technological revolution quickly eliminated familiar analog predecessors. That upset several interviewees.

"It wasn't MIDI, it was the response to MIDI which was the problem. All of a sudden you could not buy a synthesizer that would let you ring-modulate something. There are no ring modulators on DX7. There is no way to get an external signal into those instruments. Those instruments are closed worlds unto themselves. Those instruments were built in response to what MIDI had to offer as a language and that language was built around commercial popular idiom" (29:*B45).

"I was using computer control before MIDI, we had that program MASC. There were, all of a sudden, instruments that I was interested in that would not respond to analog voltage control. They would respond to some sort of digital control and that was MIDI" (29:*B540).

The reception of new tools was just as social as technological. The field, traditionally located on the margins of both art and popular music suddenly found itself in the middle of rapid commercialization. The avalanche of equipment unleashed with the success of the first MIDI synthesizers and its constant advancement and upgrading, put a new kind of pressure on the shoulders of composers, the necessity to obtain the latest, more powerful equipment at a speed by far exceeding the slower, pre-MIDI pace of technological change. This necessity was often the product of aggressive marketing on the part of music manufacturers for whom the constant race for updated and perfected gear guaranteed continuous profits.

"The technology changed so quickly, it never stabilized. Plus all the work I had to in administration, I couldn't keep up with the technology. For example, the piece I started working on was for GS1 which was the first FM keyboard instrument that Yamaha started to produce and the idea was that that was going to be around for a while. Of course it wasn't, I had to abandon that. Then I moved to forms of DX7 technology and that did persist longer, but the machines often kept changing underneath faster than I could get a piece out" (42:*A145).

In one peculiar case it caused some very 'creative' resistance.

"There is something odd about the way that the MIDI gear always to me looked like I had to get onto the technology bandwagon.[..] I've always found ways to try and do music without spending a lot of money because I don't have the money. I can't afford to buy a synthesizer one year and a synthesizer [another year]. It really was a conceptual vehicle in many ways. When you spot what MIDI can do, you begin to think about how else to do it without using MIDI" (08:*A253).

4.5 Evolution of the Evaluation of MIDI

Surprisingly, half of the sampled population (51%) have changed their opinion about MIDI over the time MIDI tools have been in use.[67] Overall, the breakdown of favorable/unfavorable opinion percentage evolved from 54:46 at the time of introduction to 80:20 currently. One can observe a remarkable evolution of attitude to MIDI technology in the surveyed group from roughly evenly divided in the beginning to the absolute majority favoring in the end.

	CHANGE		POSITIVE		NEGA-TIVE
	Yes (negative to positive)	Yes (positive to negative)	Yes (positive to positive)	No (remianed positive)	No (remained negative)
Changed evaluation of MIDI over the time MIDI has been in existence	15	3	5	16	6
Percentage	33	7	11	36	13

Table 6. ***Evolution of Evaluation of MIDI***

4.5.1 Positive Evaluation

MIDI has been viewed positively at all times by 21 (47%) of 45 surveyed composers.[68] A positive opinion about the new technology in general did not always translate immediately into MIDI pieces: some composers wrote their first MIDI works later than the time of their introduction to MIDI.

Sixteen composers, roughly one third of the sample, demonstrated a positive attitude without fluctuations of opinion. There is also a smaller group "**Positive-to-Positive (Change)**" which pointed out different sides of MIDI being favorable at different points in time. MIDI technology developed intensively over the period of its existence. Some of its early problems have been solved or minimized in the course of development. That brings about critique of the early limitations, even when the overall attitude to MIDI is positive. On the practical side, working with MIDI tools could have produced various degrees of interaction as well as various degrees of knowledge of the tools' capabilities. Accountable to all these reasons, evaluation of the tools and their application in compositional practice has changed over time in that group.

There are significant differences in evaluations by respondents #10, 13, and 18 of the applications of MIDI tools to their compositional goals and methodology at different times (Figure 3). Nonetheless, the overall evaluation of MIDI remains positive:

[67] Table 6.

[68] Table 6.

Figure 3. Examples of 'Positive-to-Positive' Evaluations.

#10 "When I bought a DX, I only used other keyboards as a sound device, I used analog and DX7 together to make music"(10:*B13).

#10 "[Has your evaluation of MIDI changed over the years?] -Yes [...] MIDI is very useful to use in sound installation works. It is possible to make complicated sound and phrases in realtime according to the data from environments" (10:*add1; *add2).

#13"Clearly it [MIDI] didn't allow you to do the totally general approach to the orchestration. You were bound to a certain number of channels and the channels played instruments, presets that you either constructed yourself, or came from the library, what have you... So your flexibility was limited to instruments at hand that were connected to some MIDI, [which] was not an integrated environment, [e.g.] let's say, mainframe situation, software synthesis, where you might have a wide variety of possibilities synthetically but they are cast within the uniform software environment. In this case you have a wide variety of instruments and they all have a different MIDI jack. That was a limitation" (13:*A210).

#13 "What's changed for me now is that there is a possibility of integration between environments, [e.g.] if I want to include pre-calculated sounds, audio files, along with interactive MIDI kinds of things. That expands the synthetic possibilities because I'm back to general purpose environment computing sound, so it kind of fixes one of the limitations. The advantages have increased. I think the greatest advantage now over then is that a lot of tools that I use exist in a very integrated way and it really is regardless of what computer you choose. [..] For me it's more 'Yeah, I can do MIDI plus I can do processing of whatever, using DSP in real time, mixing it with audio files in real time', to me that's the orchestra" (13:*A238).

#18 "For me it [MIDI] was a transitional tool and it took its place rather than [occupying the place] in the center of my composition and performance world. It took its place alongside other tools, it was something that was a right tool for certain kinds of jobs. It was the right tool for interfaceability; when you need a gesture-computer kind of interaction from a keyboard, when you're not asking a great concert pianist to be the performer; if you want to deal with sample or synthesized sounds; if you want a ISPW to talk to make changes, program changes or control changes in a commercial reverberator; if you want to control spatialization metrics in some areas, it's adequate" (18:*A478).

#18 "But for me the thing that was much more significant in the past several years is the availability of signal processing. MIDI can be a really significant tool in signal processing world but DSP, especially real-time DSP, has really captured my interest since 1991-92" (18:*A478).

4.5.2 Change of Valence of Evaluation

The 'Change' group underwent a radical switch in polarities of attitude towards MIDI over the period of time MIDI was in existence. One third of the surveyed sample, 15 composers,[69] have changed their point of view about MIDI over the years from negative in the beginning to positive later on. These respondents constitute "**Negative-to-Positive (Change)**" group.

Usually acceptance of MIDI came through realization of its possibilities.

> "They {MIDI tools} didn't stimulate me, they didn't attract me. [...] I heard nothing that was of any interest because, again, the sounds were so poor. [...] I came with a project in my mind which might actually use control data in the way MIDI is implemented, I'd use it right away, no question about that. [So has your evaluation changed from that originally you couldn't see how you could actually use that?] - Sure I'd just use it as a tool" (19:*B560, 600).

The gap between the expectations of the composer for what a tool should do and a MIDI tool provides continued to narrow as the development continued. The availability of new MIDI tools with more advanced features started to bridge that gap and thus attract those composers who did not accept MIDI at first.

> "I didn't find MIDI very exciting until MAX came in 1989. At that time the programs were very simple and you didn't have the access to the sound files" (2:*A415.)

> "All the subtleness and granularity of control ... was lost at the beginning of the digital techniques and MIDI. Today you can go over these problems to a certain extent as long as you have a good synthesis engine in the back, which is what you're controlling with MIDI which is anything" (4:*B250).

> "It's harder to have refined control over the notes in MIDI than that it is using something like MUSIC 5 or software synthesis.[...] Especially in the beginning it was harder, it's becoming easier and easier [...]. MIDI synthesizers didn't allow as much control over the sound, over the data stream. You can set the voice and those become qualities of the voice which are not adjustable remotely. There are MIDI controllers and such, but early synthesizers did not allow all that much to be controlled by MIDI controllers. You compare the amount of parameters that TG77 {Yamaha TG77 developed later} allows you to control remotely to those of DX7, there is no comparison. As MIDI synthesizers have involved, every generation allows you to control more" (32:*A290).

In the case of #43, a typical sound vs. control dilemma can be seen affecting the use of MIDI.

> "When MIDI came in, for me MIDI was a double-edged sword, I've had a love-hate relationship with it for a long time. For my personal work, I resisted using it for a long time. I am heavily involved into electronic music but I am a musician who likes to have his hands on the sounds. MIDI produced a kind of standardization which was wonderful in a community sense of the music world and the industry. But particularly in its early versions and today it is still hard to get past this: it produced a terrific division between the sound generating processes and the performer" (43:*A240).

[69] Table 6.

"I use MIDI now. I try anything I can to get past MIDI. Now what I've been working on is more use of digital signal processing under direct control of the computer and it appears maybe that's a way to get back again the control of the sound that I felt was lost with MIDI. I think we're just taking baby steps in that direction, we haven't gotten far enough to create what I would call a rich instrument yet. But that's bypassing MIDI again. I use it, it's very useful for all kinds of practical music making, converting scores to sounds and sounds to scores and performances. Right now the piece that I play the most is based on a new program that I've written which is about parsing real-time improvised input into meaningful musical units and making the results available. I usually use the MIDI piano for it, so here I am using MIDI all the time with that kind of work, so that's OK" (43:*A340).

A *practical* compromise between the stylistic demands and the accessible features of MIDI equipment is evident in this example. The respondent who earlier expressed lack of interest in MIDI instruments says:

"The sounds that they offered and their control seemed to me poor and unrefined. In the sense of sensitivity. I was going to acoustic instrumental world and instruments that really interested me, and still interest me. [...] Somehow these MIDI instruments seemed to me very elementary" (43:*A315).

The respondent continues to explain the use of Yamaha synthesizers for writing film music in the 90s:

"Practical reasons. To make the same music with live instruments, at least, to hire them, to record with them, my fee would have gone there. I didn't want to invest myself. I think it also suited to the aesthetics of the films, one of them was completely synthetic images, these kinds of sounds suited quite well"(43:*B159).

The use of MIDI notation software and environment for scoring was the reason for another composer to use MIDI tools. "It's a practical thing. [...] It's practical in my field. Also it's less tiring for the hand" (20:*A540).

The degree of involvement with the MIDI equipment may have also contributed in some cases.

"My opinion [on MIDI] changed because I learned how to use it" (22:*B500).

"Now I see what I can do with MIDI and it's very practical. I use it on a purely practical level as an I/O device. [...] There are lots of different ways where MIDI was useful for me. I just mixed a CD in the ProTools. It was very useful for a real-time interactive piece, for instance, the flute and ISPW. [...] I just did a concert a month ago where I used MIDI sliders as input to control synthesis so it's useful" (27:*B130).

New compositional goals would also attract interest to the tools best fulfilling those goals.

"I didn't need to use it because I was not using samplers until I felt I wanted to play the synthesizer to send commands to the sampler. I think it was the first time I began getting interested in MIDI" (22:*A290).

"They [MIDI tools] didn't stimulate me, they didn't attract me. [...] I heard nothing that was of any interest because, again, the sounds were so poor. [...] If I came with a project in my mind which might actually use control data in the way MIDI is implemented, I'd use it right away, no question about that. [So has your evaluation changed from that originally you couldn't see how you could actually use that?] - Sure I'd just use it as a tool" (19:*B560,600).

Re-evaluation of the possibilities of MIDI tools is evident in the following answer explaining a composer's transition to MIDI tools.

"[I was] seeing that MIDI was quickly becoming a lot more powerful than what it initially seemed to be, was more than just connecting keyboards to different tone generators, I could send out some floppy disks with the samples on them or there's ways of actually moving data around, moving sounds around cross-platform. By the time it all became apparent, then it seemed this is the correct tool to be using. [It] would let me make a piece more generally performable and it was simply a standard that was being embraced. Despite its perceivable limitations even then, it seemed like more potential was [coming] on than the limitations" (18:*A230).

There is a small, (3 composers), "**Positive-to-Negative (Change)**" group that went in the opposite direction. Its compositional demands have outgrown the capabilities of the tools.

"I use MIDI for one part of the job: for the score following. Sometimes I use it very often for detection of velocity of the piano. If I want to make spatialization according to the dynamics, I use MIDI for that kind of thing. ... For me now MIDI is a good interface for a polyphonic instrument. ... We are accustomed to work with MIDI, but for me in [a major] part of the situation, MIDI is no more satisfactory, we can change [from] MIDI to other kinds of code" (3:*A398).

"[Over the years my evaluation of MIDI] has actually become worse. I see more and more the problems and the dangerous influence it has on the education of people who only see the world through MIDI. They think differently and I think they think in a way that is not interesting musically for the kind of music we're talking about. I'm not against MIDI if you want to do music that fits it but our sort of music needs a certain control and a certain sophistication in terms of the usage of the electronics. [...] For the things I know how to do, I think, it's more and more dangerous and the quality is less and less good" (17:*B195).

4.5.3 Steady Negative Response

Table 6 shows that opinion of 6 composers (13%) remained negative. Considerations causing change in the opinion with the composers in other response groups did not affect these and thus the evaluation of MIDI has not changed. In this group, the attitude of 6 composers (13%) towards MIDI remained negative. "MIDI has not changed so we still have the same problems" (23:*B480). Chapter 4.4 "Reception of MIDI" has already demonstrated and analyzed the appropriate reasons for this type of reaction.

4.6 Learning and Incorporating MIDI

Majority of composers (68%) agreed that *"MIDI tools were easy to learn, install, implement into the composition environment."*[70] The purpose of the question was to investigate the process of absorbing new tools and integrating them into the setup for composition. The question excludes the problems of accommodating compositional ideas and satisfaction with the tools.

> "I found no difficulty with the tools. Remember that I come from a very traditional musical training and all of my background was in analog synthesis. MIDI, albeit has many limitations, solved a lot of problems I was already having" (29:*add2).
>
> "It was really a lot easier" (40:*A420).

	Yes	No
MIDI tools were easy to learn, install, and implement into the composition environment	26	12
Percentage	68	32

Table 7. ***Learning MIDI***

This process was not always rapid and smooth. Several composers noted a curve in their adaptation to new tools:

> "I found them easy to learn. [...] The initial learning curve was harder, figuring out how I can make it do what I want was harder, initially. [...] After I figured out these techniques of working around MIDI to make it do what I wanted then everything was much quicker" (28:*B80).
>
> "It's a different curve. With MIDI it's an algorithmic curve. You go very high very immediately, but then you stay there. With the other, it's an exponential curve, it takes a long time to go high but then it's infinite" (17:*B220).

Rothstein in the preface to his book on MIDI (Rothstein 1985) points out lack of reference literature on MIDI in its early days which made learning new tools much harder than now that there is a proliferation of MIDI textbooks and monographs. "When I first began making the transition to MIDI from music synthesis systems running on mainframe computers, I looked around for a book to supplement the *MIDI 1.0 Specification*. I read several MIDI books that were available and found that I learned little beyond what I already knew from the MIDI specification. More often, I found interviews with musicians, discussions of specific brands and models of MIDI equipment (most already obsolete), and generalities regarding the fabulous possibilities of MIDI" (Rothstein, Preface XV).[71]

[70] Table 7.

[71] As I already mentioned in the Introduction, I encountered a similar problem starting our research in 1995: there was a good number of reference sources as well as all kinds of literature cited by Rothstein, but

A lot of MIDI concepts originating in its keyboard-oriented approach were obstacles on the way to adaptation for composers who did not think in keyboard terms.

> "You had to translate, for instance, *velocity*, all these names that were created for a particular thing and then try and figure out 'Is that what I want or something else?' [...] And that was because of a very big misunderstanding, or maybe, it's just a cleavage between general uses of, say, keyboard player and the composer where keyboard player knows what *aftertouch* is and uses it all the time and I know but it never occurred to me to do with *aftertouch* what I was doing with the envelope follower, I never would think that that's what it was. Or *key velocity*, how's that associated with clicks of my tongue, you had to translate. [...] It [understanding] wasn't immediate. As soon as I could neutralize the concepts, then it was pretty easy. To a large extent, the early MIDI instruments, except for the Yamaha, were not terribly friendly to that neutralizing factor." (21:*A530).

Surprisingly, a technical representative of Roland, one of the major MIDI manufacturers, sides with our respondent on this point. "A lot of problems come from hearing the language, but not having the same set definitions for the terms. Things like *omni, poly, mono, channel, default*, all mean different things to different people. Yamaha encountered the same thing when they introduced the DX7 and 9, because they dealt with a whole new kind of terminology. They had *algorithms* versus *VCOs*, *VCFs*, and *VCAs*" (Jim Mothersbaugh in Milano 1984a, 48).

That the layout of MIDI equipment could be entirely different from one setup to another slowed down the learning speed in some cases.

> "It always required a radical change in your compositional environment. The compositional environment prior to that for me was either a mainframe computer or a writing desk. It's very different to go from that to MIDI in any case" (34:*B130).

When adapting to MIDI after analog synthesizers, the main difficulty in learning was the change from the manual patch-bay connection to a digitally operated menu browser.

> "It seemed quite obscure. That may be in part in the way we interacted with it using its own onboard editing environment and it seemed quite obscure and quite unnatural after thinking [in terms of] analog synthesizers. Not that I ever used synthesized analog sound, but just on the front plate of the AKS, you had a little patchbay there and any input could go into any output, it had no mistakes you couldn't patch anything wrong. Just the very whole open thing, everything was there, seemed much more natural" (11:*A580).

One of the typical MIDI design features cited as impeding the learning process was the LCD screen.

> "[DX7] was just different. I had a different kind of learning curve to it – probably, the only thing that I hated about the DX7. I liked the sounds, they were good but I didn't like the screen, I think it's horrible you have to work on that little tiny thing. In the beginning that was horrendously difficult. I never quite mastered any of the techniques to make it easier for myself" (37:*A499).

few sources on the research subject.

The same problem, as well as the difficulties with documentation are cited in this reply:

> "[When you had a chance to try MIDI instruments, did they appear easy to learn and operate as opposed to analog ones?] - Worse -- because the documentation is hard to plow through and some instruments (like the Kurzweil in Studio E) have a display that is difficult to see although that wouldn't be a problem if you're using a computer monitor" (16:*add2).

4.7 Use of MIDI in Composition

Of 45 electroacoustic composers interviewed, 30 (two-thirds of the entire sample) have used MIDI for their pieces on a regular basis.[72] Eleven cited use of MIDI on a minimal basis, peripheral to their pieces and/or, their use in only one piece. A good example of the latter use is a composer who used MIDI in only one piece, being quite prolific before and after. In that particular piece

> "The use of MIDI in this work is fairly minimal. If I remember right, I played a MIDI keyboard connected to a NeXT which captured timing and note information. I translated the note information into values that could be used in the filter program (1 octave per channel, I think) and took some of the timing values and used those in between changes in door direction.[73] That's about it, really" (08:*add1).

In the case of #20, the use of MIDI was limited to the use of MIDI synthesizers as sound sources in several works among acoustic instruments in the overall acoustic ensemble. No transfer of information was involved.

	Common	Rare	No
Use of MIDI for composition	30	11	4
Percentage	67	24	9

Table 8. ***Use of MIDI***

The decision to use MIDI equipment has been determined by the balance between the assessment of its advantages to express compositional ideas and tolerance of its limitations.[74]

The use of MIDI instruments also depended on the aesthetic criteria of the composer and the availability of instruments. For example, answering our question about why the use of MIDI did not go beyond the use of a MIDI sampler in otherwise complex live setup, respondent #41 replied "I am more interested in the quality of sound than in the control of it" (41:*A313).

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[72] Table 8.

[73] The studio door was used as a sound source in this piece.

[74] See Chapters 5.1 "MIDI Specification: Implications for Compositional Practice" and 5.2"Design of MIDI Devices: Implications for Compositional Practice".

Four composers have shown no interest in the use of MIDI equipment.[75] These are among the six composers whose reaction to MIDI remained negative throughout the years MIDI has been in existence.[76]

	Yes				
	All available answers	Common use of MIDI	Rare use of MIDI	No use of MIDI	No
Use of exclusively non-MIDI environments for composition after introduction to MIDI	27	13	10	4	16
Percentage	100	48	37	15	100
Percentage segment of the corresponding group	63	43	91	100	37

Table 9. ***Non-MIDI Environments after Introduction to MIDI***

When asked if they continued to use exclusively non-MIDI environments after introduction to MIDI equipment, 63% (27 out of 43 composers) responded positively.[77] Only 16 (roughly one third) showed complete transfer to MIDI tools. Of those 27 composers who have used non-MIDI equipment after introduction to MIDI, nearly a half (48%) used MIDI commonly. The percentage of the users of non-MIDI environments after introduction to MIDI is a little less (43%) among *common* MIDI users, but much higher among the *rare* MIDI users: almost all of them (91%) cited using exclusively non-MIDI systems. Needless to say, those four composers who have never used MIDI, used exclusively non-MIDI environments for composition.

The mixture of MIDI and non-MIDI tools can be illustrated by the following excerpt:

> "Even if in the beginning it was clear for me, it {MIDI} was limited. I used that in a very pragmatic sense, trying to have the best of the two worlds: using MIDI as soon as it was available to do things which will not suffer from these limitations. I would hardly imagine even today to do a piece using MIDI only, or only MIDI devices" (04:*B27).

4.8 Transfer of Pre-MIDI Compositional Methodology into MIDI Environments

28 (76%) of 37 composers who answered the appropriate question attempted to transfer their pre-MIDI compositional methodology into their MIDI pieces.[78] The transfer was successful with 20

[75] Table 8.

[76] See Chapter 4.5.3.

[77] Table 9.

out of 28 of these composers. It was partially successful with 18% who tried to transfer their practices, the failure to transfer was present in the answers of the remaining 3 composers. Hence, a majority of composers successfully transferred their pre-MIDI techniques into their MIDI pieces. The real answers however ranged anywhere from "I developed ideas compositionally and technically that I used in pre-MIDI pieces that I completely ported over and carried over to use in the MIDI system with no dissatisfaction" (18:*B370) to "Everything I've done so far could not have been done with MIDI. None of the pieces where I did not use the MIDI can be replicated" (19:*B90).

	Yes					
		Of those who answered 'Yes'				
	All	Successful transfer	Unsuccessful transfer	Partially successful	N/A	No
Transfer of pre-MIDI compositional practices into MIDI environments	28	20	3	5	17	9
Percentage	76	71	11	18	13	24

Table 10. ***Transfer of Pre-MIDI Practices to MIDI***

Not a popular alternative, but present nonetheless, was to change the style entirely in parallel with the entire change of tools.

> "I've never considered that to be a useful thing to do. Why not move on? It's possible to do, you could rewrite pieces for new technology that comes along, but better to do a new work, that's more of a match to new technology" (31:*A245).

4.8.1 Successful Transfer

I. Analog synthesis practices

Direct incorporation of analog synthesizers with the aim of continuing to use their best features was only partially successful. Continuous control and random pitch generation were impossible to achieve with MIDI as this example shows:

> "In the days of the Buchla stuff I had control voltages to deal with. I had little interface devices that would let me change an audio signal or mechanical vibration into some kind of trigger or continuous controller for these Buchla systems.[...] I remember there wasn't anything [MIDI] that I had that I could do random pitch generation or chaotic pitch

[78] Table 10.

generation with but I could do that in the Buchla. So I was doing Buchla control voltage to MIDI controllers.[...] There were things in the control voltage realm that I still wanted to use, like quad locators. In the mid-80s quadraphonic panner that dealt with MIDI didn't exist, but they existed very well with the Buchla, so I was very interested in using MIDI keyboard controllers to control processes that existed best in the analog domain. (*A210) I remember having to deal with liking the Buchla patch languages that I was using but being frustrated because there were only 12 oscillators. I wanted to be able to interface that to DX7 and the first E-MU samplers, that was fairly problematic. I had to go to Jay Cooper and I ask him to modify control voltage to MIDI converter and I used it to some extent but it seemed fairly flaky" (18:*A245, *A210).

On the other hand, various smaller-scale operations understood by both systems worked out better, helping preserve the original concept of the composer.

"Some things I found I could do with the DX7 that I could do with the Buchla synthesizer [which were] not necessarily in implementing the exact FM algorithm because that was impossible but [...] transferring envelopes from the Buchla hybrid systems to the DX7, sometimes unsuccessfully, doing detuning things like there were two voices that were slightly detuned at pitchbend until they were not detuned any more; glissandoing pitchbends with very precise break points that I'd been able to do with the Buchla I was also able to do with the DX7" (18:*A280).

Several examples show how a compositional idea born before MIDI tools is implemented with MIDI tools.

"Over that transition period, just before I bought the digital synthesizer, I was working on some things in analog domain and kind of the same idea of complex glissandos crossed over this point and spilled into the digital realm. One part is MIDI, [...] because of repeatability. If I want to assemble 12 layers and I am working with glissandos that have to do something very definite, it would have been very difficult to play those things by hand because notes have to start at precisely the right moment. I could have done it by hand without using MIDI, it was just the automatic way of playing my sequences" (33:*A410).

"The intermodulation between one instrument and the other, from one voice to the other, I've done that with the Buchla system. And I use that on this system [MIDI] now" (3:*B198).

In the following excerpt the concept of a MIDI controller of sampled sources originates in an analog controller.

"Yes, the idea that you can play the instrument intuitively comes back in the Web. The "X" is an instrument that consists of wires and these wires are sensors. When you touch the "X", you touch all the wires at the same time, but depending on the place and the pressure you apply, you change the tension pattern of all these sensors in one intuitive movement. [..] That comes straight from the analog model of the "XX" box, that's exactly the same. I never realized that while working on the "X" that it'd be so close to analog experience" (23:*B310).

Despite the successful substitution of a MIDI sequencer in place of the analog one, certain important features were missed in the following transition.

> "I went from the Buchla 400 system which had an excellent sound editor at the time to using the Opcode synthesizer sound editor and I would say Buchla was just as good as Opcode.[..] *B285 I was using what Buchla called the 'sequencer' that was not a time-line sequencer but an event sequencer that could do looping, conditional kinds of things and could take a real-time input as a stimulus or trigger to control the sequence. That was much more advanced than the Opcode or Performer sequencer when those came out which were time-line based and could not be influenced at all from real-time interactivity. The user-interface was more friendly [with MIDI] but flexibility was worse. So, for me there were some really severe tradeoffs, all the notes and more of it than I ever wanted to compose were instantly available if I wanted to compose them according to a time-line. If I wanted to compose according to interactivity or data flow it was not as powerful" (18:*B260).

Tracking events live was possible in both analog and MIDI environments. "The same stuff I used to do with ADC input, voltages going in, I do with MIDI instead" (27:*B170).

An interesting example of transferring the experience gained with non-real-time pre-MIDI tools to the real-time performance with MIDI is given in the following excerpt.

> "[In my MIDI setup] you could control up to 10 parameters at a time with MIDI controllers. You could assign a MIDI controller number to up to 10 parameters of every program and then control the parameters of the program from any other MIDI device. So that meant you could manipulate sound real-time in the performance, feeding sound through the processor. For example, in "XXX" I had the sound of the motors going through this box and I changed the pitches of the resonant filters from the keyboard and that was very direct, now I use the Buchla Lightning and I have algorithms on the computer that generate all kinds of stuff and all that [..] controls filtering sound in a much more complex way. That was something that was a big win for me because that allowed continuity between what I was doing with the mainframe and the Samson Box and then finally in real-time, on-stage I could a lot of the same things" (31:*B353).

The practice of converting non- or pre-MIDI sounds to samples controllable by MIDI is a common way of transferring timbres.

> "I used MIDI only as control stream in a rather simple fashion without coming close to the limit of MIDI-bandwidth -- the signal processing I did in the sampler was certainly influenced by non-MIDI experience -- I transferred some of my non-technological compositional experience into MIDI by utilizing "manually composed" structures from another piece (which was written for instruments I built myself) by importing these structures into the sequencer (manually, again)" (19:*add3).

However the extent to which the samples were malleable was limited.[79]

[79] See Chapter 6.2 "Timbre and MIDI."

II. Software synthesis practices

Addition of MIDI interface to the already existing algorithmic environment was seen as the way to facilitate the transition.

> "When MIDI came out, we adopted MASC so it would run on MIDI instruments. We created a function called *note-on*, function called *note-off*, all of the things that are parts of standard MIDI spec we then had words for in MASC. They [MIDI ports] were [then] built into the computer" (29:*A420).

Compromise was the only way to adjust a pre-MIDI software environment to MIDI conditions. The following excerpt shows how a pre-MIDI software environment has to change to become MIDI-controllable.

> "MIDI was starting and the Macintosh [..], all that started to grow and it became clear that if this software project [HMSL software, developed and used at the time] was going to be disseminated and used and made available to a large community of people, it's going to have to incorporate MIDI and become more and more MIDI based. Slowly it became primarily a MIDI-based program although its data structures, programming techniques and everything [else] were not based on MIDI at all but based on a much more basic level of our understanding of musical perception units. [Was it easy to convert that to MIDI?] - No, it was not easy. It was easy technically but it was not easy conceptually. It was difficult to make the compromises that we knew we had to make to get basically off the low-level controlled sound and work mainly at the structural level and not be bound by the concept that everything has to be considered a note. In electronic music, we didn't have to deal with notes. We could if we wanted to, but those were the automatic fundamental assumptions of what a low-level musical unit is. With MIDI that came back again. All of a sudden you're stuck with dealing with notes" (43:*A320).

'MIDIfication' of the MASC package went much smoother since the functions of the package were much closer to those of MIDI protocol.

> "MASC was a software replication of all functions that were available on an analog synthesizer. All of the control devices that existed on an analog synthesizer were available now as software objects that could be controlled by master programs. The only difference between the hardware and software objects with MASC is that they were expanded. I was not limited to a number of points in an envelope, I could have a 5000 point envelope if I wanted to. I could restructure random seeds with the random voltage generators. When MIDI appeared, the only difference is instead of sending the result of the programming to the D/A port, I send it to the MIDI driver instead. When MIDI appeared, there was no change in the nature of MASC itself, it's just information was going to a different spot. I had to make sure that information ended up being something MIDI could understand. The only thing that really affected was envelope generators because MIDI does not understand envelopes. Then MAX came along and just did it better" (29:*C410).

As the following example illustrates, if software was portable to a MIDI-controllable environment, transfer was successful.

> "A lot of the sounds I wound up programming on the NeXT to run in DSP were derived from sounds that I used in the Samson Box. I liked them, a lot of them were results of a

lot of analysis and hard work. So, I just ported a lot of them over. And then, of course, they were MIDI controllable because they were on the NeXT" (31:*A350). "This program I just talked about, [...], yes, it {transfer} was successful because I was doing the same with MIDI and the sampler that I was doing with CMusic dealing with sampling. It was an equivalent for me" (44:*B256).

With software ported over, sounds converted to samples, transition appears mostly successful. However, limitations of samplers make the sound less controllable and changeable than in pre-MIDI years.

"Some of the software I was using and the concepts I was using in the software I ported directly because I was writing in FORTH computer language on a small processor, there was a good FORTH version on the MAC at that point. What happened was I started to realize that the software was the part of the instrument I was using, that I wanted to keep on developing that side, it was much more practical to do that on a modern computer with the disk drive and all those things (I used to load myself up from tapes, in the 80s!). The software part transfer ... [was successful]. The hardware part was more of the problem, because I still liked acoustic sources and instruments in my pieces and often I'm not using synthesis directly. Eventually I went to samples. A lot of 'sculptured'[80] instruments I sampled and I use them now in that form. So that was the transition that happened to me: from the sculptural instruments that I played, eventually I sampled those instruments. [..] And I'm not particularly happy with that because of the limitations of commercial samplers: the fact that you've got to play the sound back from the same point every time. I'd be interested in either much more flexible sample-oriented playback system which I think is around the corner pretty soon with small computers or else in modeling systems but none of them so far is all that successful. I'm not really happy or that experienced with commercially available systems" (40:*A185).

Shaping of the envelope became the barrier to transition to MIDI tools. Even more sophisticated MIDI controllers, e.g. breath controller, were not sufficient to represent the complexity of pre-MIDI sounds. Again, the compromise between the limitations of MIDI and the potential of software is seen as a solution.

"I felt that electronic music was a language of electronic gesture and dealt with pitch and envelopes as gestural qualities than specifically notes and pitches. When I created instruments I created a sound [produces a complex vocal sound], there were no sounds like that in MIDI language. They were tooled and made to deal with particular kinds of envelope shaping that I was looking for. I used, for instance, in "XXX" which was pre-MIDI, I used the cellos with an envelope follower so that they'd make their different changes, it {the follower} would make the sound spin in different ways and vary the tones that would be made by cello. When I first got with the MIDI devices, the first thing I did was use the wind controller and various kinds of things that would give more human shaping [of] sound to it. (*A297) Even the wind controller couldn't get the envelope I was after, from the very beginning they were much better in the analog [domain]. And to some extent I had to compromise what I was doing slightly in terms of the extremities, so what I went to was the sampled sounds so I could get the sounds the I wanted, but it wasn't being generated, it was pre-created and only slightly modified, it wasn't like the sound that would evolve like it did in my pre-MIDI pieces. [..] That's still a ways off. The computer still can't follow fast enough, that's still not there yet" (21:*A206, *A297).

[80] Custom-built electroacoustic sculpture-like machines producing their own sounds.

Controllers could also fall short in terms of complexity as illustrated by this excerpt.

> "[Did you try to recreate with MIDI some elements of your pre-MIDI compositional practices?] -Yes, that was when I first tried the wind controller. [...] It wasn't terribly successful but that's what I was doing: I was trying to transfer some of the things I did with the envelope followers to the wind controller and that was only partially successful because the subtleness of the vocal stuff just wasn't there" (21:*A500).

4.8.2 Unsuccessful Transfer

One of the composers attempted to continue to use his method of interpolating sounds working with contemporary software synthesis but has found it impossible to accomplish with MIDI. Change from the continuous, texture-oriented facilities to ones favoring notes and fixed values is responsible for this failure.

> "One of the things that now is very easy to do with computers which is to take sound A and sound B and interpolate between them is something I worked very hard on in terms of the analog being able to do what I call 'linear-timbral transformations' from one thing to another which other people weren't working with. And that had to be accomplished real-time. Those kinds of things sort of went out the window when I started dealing with MIDI. You are more concerned about working in the event-lists, stating all the specific information for each event and worrying to get an external hard [drive] to sound relatively decent instead of the factory sounds that everybody else was using" (6:*A323).

In the following case the limitations of MIDI necessitate a search for a complete change of practice as the transfer is impossible.

> "Not to do the same thing, because the same thing you can not do. I'd always been working a lot with analysis, synthesis, and resynthesis. You can not do resynthesis with MIDI, this is one borderline MIDI can not cross. MIDI is a macro time protocol, it is not dealing with analysis and resynthesis. On the other hand, yes, you can play with these borderlines" (44:*B200).

Chapter 5

Assessment of MIDI Technology from the Perspective of Composition

5.1 MIDI Specification: Implications for Compositional Practice

MIDI protocol, in its design and regardless of how it is implemented in MIDI devices, possesses features that facilitate or constrain electroacoustic art music composition. Despite the fact that composers working in the field have found ways to bypass most of its limitations, for example, fixed temperament, solutions do not eliminate some inherent drawbacks of the protocol. But first let's analyze the advantages of MIDI specification.

5.1.1 Advantages

I. Real-time

MIDI works in real-time. It allows immediate response by the receiving device to the command sent from the controller. The composer/performer both in the studio and live situations can now rely on the selected function to be performed without audible delay.

> "Instantaneous production of the sound: as soon as you get out the key on message and all that, it kicks out the note. The way that I'm playing my new phrase, piece of music I am going to compose with, it's being played by the computer process. As soon as I start the process, it starts to send those key-on messages. So it's instantaneous creation of this thing that I've never heard before, possible in 1987 only because there was a Macintosh and a MIDI cable running to some portable keyboard, sampler, what have you... That was the technology that allowed that kind of experimentation" (13:*B1).

However, real-time is a relative concept. There is always a certain, no matter how minimal, amount of time elapsing between the emitting of a sound and its final recognition by the human

brain. This delay may range from milliseconds to days as it used to be in software synthesis. Loy analyzes in detail the relation of MIDI bandwidth to real-time by measuring the time delay between the recognition of a 10-note chord sent down a MIDI channel. He concludes that "the smearing is not liable to be heard as multiple attacks, even when percussive timbres are being synthesized" (Loy, 17).

II. Compatibility

The protocol allows transfer of MIDI[81] data between all devices that have such facilities notwithstanding their age, or brand. MIDI facilitated distribution of tasks between highly specialized units[82] with the possibility to choose between different brands to select the desirable device.

> "What's changed for me now is that there is a possibility of integration between environments, [e.g.] if I want to include pre-calculated sounds, audio files, along with interactive MIDI kinds of things. That expands the synthetic possibilities because I'm back to a general purpose environment computing sound. [...] I think a greatest advantage now over then is that a lot of tools that I use exist in a very integrated way and it really is regardless of what computer you choose" (13:*A238).

III. Control

MIDI allows the administration of descriptive characteristics of musical events, namely time of their beginning and end, pitch, amplitude, timbre assignment, spatial position etc. One controller can be used on several controllable instruments simultaneously, letting the sounds come out independently in a multi-timbre texture or layering them all into one. In its *omni* mode the MIDI controller sends out the same information on all channels. Taking this one step further, its *poly* mode lets the user select which instrument receives which information specified by the assigned channel. The controller's keyboard can be split into multiple parts to control different devices, or samples. Non-keyboard (drum, wind, string, breath) controllers are available for more sophisticated control. Because of generality of commands MIDI even allows the control of one parameter through another.

> "What is important in MIDI, in fact, is all the different kinds of events: pitch, velocity, other kinds of things that are written in this same range. You can control spatialization of the sound with velocity, duration with pitch. You can make communication between very different parameters and that was not possible before. Now all different parameters speak the same language" (3:*A436).

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[81] And sometimes MIDI extensions.

[82] See Chapter 5.2.1, section III.

IV. Precision of digital data

MIDI transmits precise values. Since the transmission of data happens in digital form, it is not likely to be affected by parameters like, for example, temperature in the case of analog synthesizer. Precision of transferred data enhances reliability of the process.

> "It was a lot simpler to me to be able to definitely say as a programmer "I'm going to play this sound now and it's going to play for this long. I can count on a time between the onsets of this long, and I can count on that percentage of that sound being on. And then I don't have to worry about what comes out" (15:*A375).
>
> "The precision of highly accurate notes rather than inferred notes, being able to MIDI keyboards and mallets gave me a lot more input" (18:*A300).

5.1.2 Limitations

In his thorough analysis of MIDI in 1985 done from the point of view of art music, Loy sums up limitations of the MIDI protocol in one paragraph: "The limitations include limited bandwidth between devices, limited frequency and time resolution, limited access to synthesizer parameters for such things as timbre modification during synthesis, and lack of bidirectionality in communications. The conception of music embedded in the standard seems archaic and inflexible, and favors piano-keyboard type synthesizers" (Loy, 8). We will look at each of these in more detail.

I. Event-oriented design

MIDI is designed to control the transfer of information about events, not of the audio itself. "What MIDI communicates is [...] human gestural control information" (Loy, 9). He also notes that "because of the crude nature of time control, MIDI is utterly inadequate for phase-level control of waveforms. This means synthesis of a single-fused timbre can not be split reliably across MIDI synthesizers. This would also rule out control of stereo or dichotic sound imaging via MIDI" (Loy, 17).

The way the specification is written makes it impossible to directly control the synthesis of sound, or any other process involving the continuous flow of audio sample data.

II. Limited range of values

MIDI supports a fixed scale of 128 values applied to any parameter both the controller and the 'slave' receiver device understand. In many cases, the resolution of such scale is not enough. In other cases, while the overall range is satisfactory, the possibility to zoom in on a certain part of the range and divide it finer is ruled out.

> "The [...] problem is 128 values are ridiculously bad. Not because I have 128 dynamic [values], a pianist does not have 128 dynamic [values], but within a given dynamic of, for instance, *mezzo forte*, he can have more 128 small shades of things around a certain value. For this you need a much higher resolution" (17:*A568).

Since the MIDI standard does not specify how to handle notes, or other values above or below its 128-point scale, it is left up to the manufacturer. In Yamaha instruments notes that are too high are usually ignored, other manufacturers, such as Casio transpose them up or down to realize them within the boundaries of the acceptable MIDI range (Hofstetter, 86).

III. Fixed pitch scale as part of fixed value design

By and large, the 12-tone scale approach of the protocol assigned a MIDI number to an equally tempered pitch, leaving nothing to directly reference the values in between.

> "MIDI makes some very dangerous assumptions: first of all it assumes that you are working in 12-tone environment. [..] All of a sudden I found myself being very concerned about the fact that I was limited to 12 notes to the octave because in the previous systems you didn't even really care what pitches they were. All of a sudden everything comes out sounding like it's a 12-tone scale and that just bugged the hell out of me" (29:*A440).

Use of fixed pitch instead of physical frequency made alternative tuning impossible in the earlier instruments. This was a giant step back from the achievements of pre-MIDI synthesis where frequency user was unbound. "What MIDI has encouraged is not to think about microtuning in an interesting way. Even though some synthesizers produce those possibilities, most keyboards, in fact, don't have any kind of microtuning layout" (23:*B575). The reason for that lies in the commercial nature of the protocol: "Perhaps owing to the clavier-based nature of MIDI synthesizers -- or to their preponderant use in commercial music, where such subtleties are seldom explored -- tuning traditionally has been a low priority for manufacturers" (Scholz, 49). Composers who wanted to move away from the common pattern had to go to great lengths to achieve it. Several manufacturers implemented their own facilities for alternative tunings, none of which became an officially accepted extension, thus limiting use of such facilities to the instruments of that brand only.

IV. Low data transfer rate

Low transferring speed at 31.25 kBaud (31,250 bits per second), lamented in early days of MIDI, remains the same now. Analysing the reception of MIDI in 1984 Milano concludes: "MIDI's baud rate is 32k. [...] That sounds like a lot, but many people feel it's inadequate. Compared to the baud rate of many computers available today, it's downright slow motion" (Milano 1984a, 43).

This rate is often too slow and thus inadequate for the fast change of parameters.[83] When too much information needs to be transmitted, the network, limited by the low bandwidth of such transmission, starts queuing up the MIDI commands (*'MIDI clog'* or *'MIDI logjam'*). This condition sometimes results in the audible delay in appearance of events known as *'MIDI lag'*.[84] Musically one hears abrupt changes in the texture: sudden end of notes, pitches sustained for unspecified time, sudden bursts of sounds.

> "Of course, there's a limitation of speed. The moment when the control is continuous, polyphonic, you have more than one voice, continuing controlling things, you run out of limits. If it doesn't crash, it delays" (17:*A568).

> "Sometimes there are 1-2 notes which areas stuck, *note-off* message does not arrive. I also tried to simulate synthetic sounds with MIDI. For instance, instead of using as series of MIDI events, series of notes, I wanted to use pitchbends on different channels and Control-7 to change the amplitude of the output and so on. I wanted to change twenty times a second 16 different parts, it was impossible, it wasn't fast enough. So, yes, there is a limitation" (9:*B301).

> "I usually use thick textures, more like symphonic sound, in a way, not just a tiny sole instrument. MIDI gets in the way because it's a very slow protocol, if you want to do more complex things, it just can't. So you just have to throttle down to what MIDI can do. [...] For example, in the kind of pieces I was doing lately [...] I'm using real-time continuous control of the sounds, timbre or filter settings. That means sending a lot of information through MIDI and it just doesn't work. I have to do fancy programming things just to get acceptable results. I don't get what I want, I get what I can get away with" (33:*B367, *390).

However, for simple operations, involving minimal transfer of information describing a large number of note events, MIDI is quite sufficient. Apparently on these grounds, a technical representative of Roland Corporation interviewed in spring 1984 disagrees with the notion of slow speed of MIDI connection: "There are a lot of people who say that it's not fast enough, but we've found that we can turn on and off 500 notes in one second. That's pretty fast" (Jim Mothersbaugh in Milano 1984a, 48).

V. One-way communication

All communication messages go one way, two-way communication is achievable but not inherent to the protocol. "The proliferation of "black boxes" for routing, mixing and modifying MIDI data is symptomatic of the limited bandwidth and the unidirectional bias inherent in the MIDI specification" (Music Machine, 179).

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[83] Moore (Moore, 24-26) offers detailed analysis of how well MIDI bandwidth handles various kinds of synthesis and controlling commands.

[84] McMillen gives a good example on how a MIDI lag is created by simply playing simultaneously two polyphonic instruments, like a guitar and a violin. Such setup necessitates processing information at 36,000 Baud exceeding MIDI's 31.250 Baud. "Simply updating 7-bit pitchbend and volume 100 times a second for six guitar strings exceeds MIDI's bandwidth -- 6 strings * (3 pitch bytes + 3 volume bytes) * 10 bits + 0.01 sec = 36.0 kBaud (MIDI takes 10 bits to transmit a 7-bit value" (McMillen, 47).

"Initially you could only pass data in one direction, you had to have another line of MIDI to pass data in another direction. Immediately that was seen as a limitation by most of us, that we didn't have communication back and forth like this on the same line of transmission" (14:*A275).

VI. Limited number of channels

The number of channels on a typical MIDI device does not exceed sixteen. That obviously creates problems in instrumentation, limiting the number of possible connections and channels to be used. "Clearly it {MIDI} didn't allow you to do the totally general approach to the orchestration. You were bound to a certain number of channels and the channels played instruments -- presets..." (13:*A210).

5.2 Design of MIDI Devices: Implications for Compositional Practice

MIDI tools for composition and performance vary widely in their formats and purposes. It is hardly possible to single out the same element and then contemplate its accessibility for ***all*** kinds of tools. However, the general turn to higher accessibility of tools which started in the early 80s with the PC revolution, eventually found its way to art music as well in the wave of MIDI-controllable applications and devices. A lot of design problems and benefits impacting the way MIDI tools have been received had nothing or little to do with MIDI proper. As one of the respondents said, "It's not MIDI, it's what you do with it but MIDI is the filter by which it's passing" (4:*C6).

Table 11. ***Design of MIDI Tools***

	Better	Worse	Mixed
Comparing instrument design of MIDI tools (user-friendliness, accessibility) to pre-MIDI tools	19	22	2
Percentage 1	44	51	5
Same among common MIDI users	12	16	2
Percentage 2	40	53	7

Opinions on this subject divide into two similar-size groups: 19 respondents deem MIDI tools *'better'* in their design than pre-MIDI tools and 22, *'worse'*. Two respondents strongly share both opinions. Among the artists who use MIDI commonly for their works, the disappointment rate is slightly higher: 40%:53% vs. 44%:51%.[85] These numbers do not present the full picture as the focus of comparison is too wide. Instead a panorama of opinions will help illustrate the community's reception of the new tools, regarding their accessibility and where their advantages and disadvantages lie.

5.2.1 The Positive Aspects of Design of MIDI Instruments

The positive sides of the new instrument design are the same for MIDI synthesizers, MIDI software applications, MIDI auxiliary effect devices etc. The features mentioned most frequently by the composers are:

I. User-friendliness

> "I think it has quite a good deal of user-friendliness. Sometimes it depends a bit. To program a MIDI synthesizer, sometimes it could be easier but there are constraints like even the dimensions, the number of keys... But by and large I think it's fairly good" (38:*C130).

> "It {MIDI equipment} was extremely convenient because what was [available] before required more technical knowledge. It facilitated, simplified the access to the technology which became available to many people. I'm interested in that. [..] It's easy to access the technology" (36:*B160, *B195).

User-friendliness was not consistently reported. Problems continued to appear, in particular, in software control of the synthesizer.

> "Really it isn't that much different. Before I had to program everything on the mainframe (Samson Box) using fairly elaborate programs that were not particularly used-friendly, they didn't have a graphic interface, anything like that. That was pretty tedious, I had to write a lot of stuff, which was really NOT user-friendly. And then there was a transitional period when I tried to do some things using LISP on the Macintosh and MIDI, DX7 and stuff like that. That wasn't too successful. I never really did anything serious with that although I recorded "XXX" using that, Dyaxis, and some software synchronized MIDI. That was somewhat user-friendly. After that I got involved in NeXT. I started going back and just programming the computer again, this time to do MIDI control instead of synthesis directly, actually synthesis too. That wasn't user-friendly at first but we did design some software that became more user-friendly. Working with the devices themselves I don't find that too much of a problem" (31:*B400).

[85] Table 11.

II. Portability

In 1982 Loarie cited lack of portability as one of the three major flaws of pre-MIDI instrument design. Bulky units were based on regular (non-micro) processors and manual patchcord connection necessitating multitrack recorders adding to the space and weight up to "100sq ft and 300 lb or more" (Loarie, 8). It made pre-MIDI equipment uncomfortable to operate in the studio environment and live performance normally impossible.

> "In performance there was no way to do that {improvisation} because the Moog, although that thing was called 3P for 'portable', but give me a break, it's not portable. [..] We had a rule that Moog didn't move, we tried a couple of times and something would break, it was not available. [Sounds like portability was a problem?] -That is true" (39:*A285).

Portability of MIDI instruments, based on microprocessors (predicted by Loarie), has been crucial for the success of interactive performance with MIDI instruments.

> "Around 1984 the Macintosh came out. We traveled with it, the Synclavier system, a lot. We must have done several hundred concerts all around the world. I had it in three suitcases. they were very heavy, but it was packed in such a way that I could fly with it anywhere. [...] In fact we never had any serious problem with it anywhere, in the performance it was a wonderfully built system, but it was heavy. I always thought that I was fortunate, because my life was in sync with development of equipment. As I'd get smaller and weaker, the equipment got smaller and lighter. I had to take advantage of that in 1980 - 1986 because I was really tired of lugging around with this big equipment and with the Macintosh and MIDI there seemed to be a whole new approach. [..] I saw these MacPluses, you can throw them over your shoulder and be off with the DX7. I thought that was much lighter, more portable, definitely more developed" (30:*A128).

> "The size of things has shrunk drastically. Now you can take small thing out on the road with you, it's a such smaller package. Previously you'd need these huge roadcases" (34:*B180).

> "In terms of access, [it] was the portability of it, the fact that you can bring it on-stage, this kind of gear. When I started performing particularly improvisational work with cello, pitchtracker, Macintosh and some MIDI synth -- that's accessibility" (13:*B225).

The easiness of setting up MIDI equipment for concert performance is addressed in the following quote:

> "It's easy to set up. I can take a PowerBook, a little synthesizer. I can take it with me and do something with it. Those are the main reasons to use MIDI, very practical, pragmatic" (34:*A170).

> "[Has portability gotten better?] -Sure! I'm laughing because I remember the piece that I did in '64-'65. This was called "XXX" and I had 10 players, each with an apple box and little sound sources on the box with contact microphones and each had a separate channel. These were tube amplifiers that had to be used. They were very heavy, very big and there were 10 of them. We would put them all on a door or piece of plywood and then had to bring it out. [Laughs] Incredible! Times have changed somewhat, yes" (41:*A538).

"Portability is certainly a good thing. The Radio Drum and the sampler I can barely carry, that's helpful, I play that piece a lot. The Disklavier I can't carry and the NeXT machine is a little too big to carry. I'd like to get a portable setup, that would influence my next hardware choice" (32:*B560).

III. Availability of both highly generalized and specialized tools

Development of specialized devices was seen as the technological goal in Loarie's letter published in CMJ 1982. The "overgeneralized system design" (Loarie, 8) in most of pre-MIDI equipment, needed to be replaced with a combination of specified systems solving a specific compositional goal. As Moog, a MIDI manufacturer, professed in 1983: "[With MIDI] it will no longer be necessary to combine keyboard, control panel, and voice circuitry in one clumsy, heavy case" (Moog 1983, 25). Our MIDI-using respondents endorsed this development:

"It made a certain aspect of making synthesized music much more interesting and accessible to me because I didn't have to build 5 different oscillators that were modulating each other and figure out ways of controlling them. That was built into the design. In that sense it made it a lot more easy for me" (40:*A430).

"They {MIDI tools} are much more accessible, much more user-friendly in this field, that's for sure. Because they've been developed in such a way to be commercially packaged so that you have a complete product" (14:*B125).

Although the latter statement differs from the one before, emphasizing the general vs. specialized approach of MIDI instruments, together they add up to describe the full picture. There are groups of general instruments containing multiple operations (e.g. sequencing, master controlling, drum pads, voice banks, synthesis facilities, memory units etc.), mass-produced synthesizers as a good example, existing along with the tools aiming narrowly at a certain aspect of composition.

"Up until MIDI what computer music did was integrate the notion of composing sound along with composing other aspects of music. I think MIDI divided that labor in a crude way. What it really did, it allowed people to decide which part of the process they want to go into" (15:*A375).

The distribution of tasks had the positive effect of allowing the composer to concentrate on a particular part of compositional process, and also rely on a specific device to perform the task, leaving the composer free to work on a piece at a more general level.

"I kind of liked it because it was distributive. You had this idea of distributive computing: I had my computer which was doing the compositional algorithms and the computer in the DX7 was doing all the work of making envelopes and making sounds and that was wonderful. That made it easier for me to think on a higher level" (15:*A200).

IV. Economy of space and equipment

The high specialization of MIDI components provided the possibility of obtaining only a certain part of the unit (for example, a Yamaha TX voice bank instead of the whole DX synthesizer) without duplicating other parts. It also allowed the optimization of resources and attention towards performing more detailed tasks on combinations of more specialized equipment. This feature allowed the elimination of unnecessary duplication and reduction of costs and performance space.

V. Emphasis on multi-timbrality

> "I can make a virtual player who's playing a set of virtual keyboards so I could conceptualize how many keyboards I want him to play. So at this standpoint the new systems that I'm using, they could've been conceived as being 64 independent musicians, who can group themselves and keyboards any size the want. [...] I think I've just modeled an orchestral paradigm where I've got a group of instruments and I configure them how I want" (15:*A375).

On the macrolevel, multi-timbrality manifested itself in easy and flexible superimposition of MIDI instruments.

> "You have possibilities to make a very complex sound. For example, if one superposes some programs of synthesizers connected by MIDI over various transformation tools also connected by MIDI, with a traditional gesture of a pianist one can create very complicated sound. By mixing electronic sounds one can make an orchestra, I am very interested in that. This orchestra could be expanded with noises, changes, possibilities of mixing different programs -- that is very interesting" (36:*B195).

VI. Reliability of operation

> "It {custom-made analog/digital pre-MIDI synth} was a big machine to carry around. It was, in quite a big part, made by myself, and for that reason technically not very reliable. I like the idea that now these instruments get really small and that also gives you a possibility to play here on the street in front of IRCAM. With machines like that it would be very unreliable."(23:*B546)

> "First of all, you knew -- within some limits, it wasn't perfect, of course, you weren't going to blow things up. Didn't need a voltmeter, didn't an oscilloscope. I used to carry around an oscilloscope and a voltmeter and screwdrivers. Every time I do a concert with analog stuff, it would be like 'Is everything cool? Is voltage right?' I don't do that any more. [Now] I might carry a diagnostic disk with Norton Utilities but I'm not carrying around a voltmeter. The second change was that you started to be able to rely on similarity and repeatability of behavior. [..] If you told the software to do one thing and you programmed that, you set it in motion, you'd hear the same thing every time. Then it was up to you and the software to make changes. If you wanted to add more variability or whatever. At least, you had something you knew this was going to work. You could build on that, you could build more quickly. MIDI just extended that process. The first

digital machines I had -- it was just really amazing. You made the same envelope, it sounded the same. I can tell you, it was fabulous as opposed to analog stuff where every time you turn it on, it'd be like 'Hm, this is a little different. It doesn't sound the same today as yesterday'" (15:*B250).

VII. Analysis of information on microlevel

"The microscopic examination of music available by computer -- masses of sound, looking up the sound, detail of its structure -- it's opened up a universe, just like a microscope when it was invented. You see things you didn't know existed" (35:*B50). This feature made problem identifi-cation easier. "If you changed the hardware once again, if you didn't get the same behavior, it was easier [with MIDI] to find out why you didn't. And faster" (15:*B250).

VIII. Graphic interfaces

"I think at this moment [of transfer in 1991] it was a big change. I was a bit afraid before of the computers. It's quite important, with the equipment I used before IRCAM, we had to describe in informatic {computer} language a lot of things and I am not very fond of that, prefer to have graphic interfaces or anything which is much more accessible. I think with the equipment like Sound Designer, ProTools, you don't need to write a lot of commands, it's visual and very near {similar} to analog activities" (22:*A140).

IX. Uniformity of access through existence of a standard

"As soon as somebody comes up with something else that is put out on every single commercial box and I can go from one town to another, plug in my PowerBook and know it's going to work the same, I'll go for that" (34:*A170).

X. Storage facilities

"What I did with DX7 was much more convenient for me. [...] The way the parameters were stored in the machine, before that it was extremely complicated. I remember I owned a Korg synthesizer it was Korg Poly6. That was the first synthesizer where you could memorize the programs. Before that you couldn't keep the settings of the synthesizers, you had to do everything on the spot. [...] With Korg Poly6, the sound was still analog with filters and so on, but you could store in the very small digital memory the settings for all the parameters. You could have 48 different sounds which you could keep on a cassette. It didn't work very well because if the level was too high, it didn't work, if it was too low, it didn't work, if the speed wasn't absolutely OK, it didn't work, sometimes you had to try ten times before being able to store or to read the parameters it had kept" (9:*A168).

"The way it helped a lot was - that you could finally store the voice sounds [...] That was pretty useful, in analog you could never go back to the same setting. If you were doing this whole massive setup, hundreds of patchcords in there and you may want a little

change, the whole system could just ground, go very far away from where your intent was. It was very difficult, if at all possible to go back to it. Finally you are able to store these voices in the DX7, on the cartridges and additional librarians on the computer" (39:*A150).

XI. Ready-made timbres

Presence of a bank of ready-made voices can be advantageous when the focus of compositional interest is on properties other than timbre. Kaske first mentioned that in 1985: "The introduction of inexpensive digital synthesizers like the Yamaha DX series is releasing composers from the obsession of creating new timbres. I suppose it will have a positive effect on the scene in that it will help many composers who had been seduced by the rather peripheral aspect of sound synthesis to get back to the real thing called music" (Symposium on Computer Music Composition, 55).

5.2.2 The Negative Aspects of Design of MIDI Instruments

Some negative aspects arose out of apparent advantages. Sometimes the range of possibilities is sacrificed to the easiness of access, the danger that Risset warned about in 1985 in CMJ: "There is always a risk in making tools "easier', that of limiting their power and making them stereotyped. It is a difficult challenge to design digital instruments that are easy to use yet which preserve the diversity of possibilities inherent in the computer. Many digital synthesizers are difficult to reconfigure, and they provide a limited palette of sonic possibilities that is hard to escape -- hence, sonic clichés. Avoiding such clichés was one reason for going to the computer in the first place" (Symposium on Computer Music Composition, 54).

I. Synthesis implementation

To broaden market appeal of the MIDI synthesizers, the instrument's synthesis power is compromised in order to achieve the desired access features. "The effort to make synthesis easier may lead to as musical regression -- as was the case with most uses of analog synthesizers compared with the previous practice of electronics music before synthesizers were invented" (Symposium on Computer Music Composition, 55).

Yamaha DX synthesizers present a powerful alternative to computer synthesis that dominated before 1983. In fact, they started a new pattern in research and development of new synthesis tools: they switched the focus from the development of ***general*** synthesis environments (available in the form of computer software from mid-70s up to present day) to the synthesis facilities able to perform only ***one synthesis model***. Nowadays there are"... limited-function synthesis engines embedded in some of today's commercial synthesizers. For example, many frequency modulation (FM) synthesizers, such as Yamaha DX series, can do only FM, because the circuitry was designed expressly for that method" (Music Machine, 237).

The lack of continuous control over development of sound and, connected with that, the diminished complexity of sounds due to limited number of envelope points available in a digital synthesizer are cited over and over again.

> "There were a lot of things with complex envelopes like the Buchla system I was using at the time you could do 256 breakpoint envelopes, and you could do [only] 5 breakpoint envelopes with the DX7. That was quite frustrating, that was a step down" (18:*A280). "I tried to use a lot of continuous controls and I suffered a lot for that. And then I suffered from the speed problem, immediately. I wanted to use too many curves" (4:*B560).

Part of the problem lies in the design of the MIDI protocol which does not provide a way to channel information to shape the soundwave in real-time. Also its subdivision into 127 points, fixed and limited, is too crude a value scale for a physical process.

> "MIDI equipment may seem easier to use at first (simpler connections, no conversion of the signal - each type of voltage-controlled synthesizer had different norms) but when you want to do really interesting, complex, or flexible things, then MIDI can become really tricky or a real obstacle - sometimes you just can't do what you want to do. An example: we tried to implement MIDI on Ondes Martenot: it was just impossible! MIDI can not provide a good representation of continuous phenomena, microtones, and so on. For modifying timbre in real time, analog equipment finally was handier and more intuitive" (9:*add2).

The following respondent agrees with the critique, adding that the control possibilities expanded as the instruments evolved.

> "It's very easy to produce a lot of notes, but it's harder to have refined control over the notes in MIDI than it is using something like MUSIC 5 or software synthesis. It doesn't mean it's impossible. Especially in the beginning it was harder. It's becoming easier and easier. People are also becoming more sophisticated. MIDI synthesizers didn't allow as much control over the sound, over the data stream. You can set the voice and those become qualities of the voice which are not adjustable remotely. There are MIDI controllers and such, but early synthesizers did not allow all that much to be controlled by MIDI controllers. You compare the amount of parameters that TG77 allows you control remotely to those of DX7, there is no comparison. As MIDI synthesizers have involved, every generation allows you to control more" (32:*A290).

Frustration with attempts to recreate with MIDI instruments the level of complexity available with analog devices leads this composer to use samples instead of synthesized timbres.

> "Even the wind controller couldn't get the envelope I was after, from the very beginning they were much better in the analog [domain]. [...] What I went to [with MIDI] was the sampled sounds so I could get the sounds the I wanted" (21:*A297).

MIDI synthesizers are criticized for their implementation of Frequency Modulation synthesis. FM had been available in the software synthesis model for a decade before the Yamaha DX7 release but its software facilities are much more extended than the ones found in the DX synthesizers.

"The DX7 was a poor implementation of FM. This is the way we felt at that time. We knew FM inside out, the FM theory, we were able to understand the C-ratio and all that, and make complex sounds. With the DX7 you didn't have any of such fine control. The way FM was implemented [in DX7] did not seem to us satisfying compared to what we had access to. [...] So when it came to algorithms and synthesis algorithms, our tools were much, much better... much more flexible, much more controllable, much more predictable" (2:*B350).

The versatility of FM synthesis available in synthesizers pales in some testimonies in comparison to analog synthesis.

"I had developed a patch on Buchla 200 where I use 10 oscillators. I used this for everything that I did from 1977 on. They were tuned to track simultaneously in two directions. They could move in parallel, simultaneously and obliquely. [...] Literally I could program the thing to go from a sinewave to a huge noise spectrum in real time in terms of interpolation or transformation. I got so used to working with that as a kind of a basic compositional method. There is nothing that would be analogous in terms of dealing with a MIDI environment that I know now because if you're using FM or timbral modulation or granular synthesis, whatever, you end up specifying particular precise details about the hardware you're dealing with or maybe more general details about a particular process. I've never felt the kind of immediate series of possibilities and simultaneous control that I had with that before even though in a lot of other areas the control is much greater" (6:*A487).

II. Patch vs. display window design

"It's all a compromise. Usually with MIDI instruments, the design of the internal voice, the way things are connected is very much fixed. You have certain kinds of modulation, [but] the way things are connected is fixed, you can not change that. Those things are design compromises, the manufacturer has to get something that's affordable and useful for the market he's aiming at which is not particularly computer music. [...] That takes something [away] from the analog world. In the analog world which I was playing with before, the voice is not set, it's just a couple of patches, physical patches, linking modules and then you have complete freedom in arranging modules the way you want which you can not do in one of these more advanced synthesizers. You lose this 'look and play' approach literally but you gain polyphony (which came mostly after MIDI) and you gain repeatability" (33:*C5).

"It seemed quite obscure, that may be in part in the way we interacted with it using its own onboard editing environment and it seemed quite obscure and quite unnatural after thinking analog synthesizers. Not that I ever used synthesized analog sound, but just on the front plate of the AKS, you had a little patchbay there and any input could go into any output, it had no mistakes you couldn't patch anything wrong. Just the very whole open thing, everything was there, seemed much more natural" (11:*A580).

"It may be because of my training but I was trained using analog synthesizers. For me there is a kind of logic and serial approach patching an oscillator to something else to something else, manipulating things that way. That's the easiest, the most comfortable thing because of the way I was brought up. It doesn't mean it is necessarily better and if I was brought up using FM synthesis as implemented by DX7, that would be easier for me. [Synthesis with MIDI equipment] wasn't easier necessarily, it required a certain mind shift" (25:*A335).

"Still today you can not get in and in real-time tweak with the sound the way you could with those analog systems. You can't step inside the sound with the ease you could with those patchable systems. They are getting there, some of the more innovative manufacturers. [...] Roland made this great instrument called JV-80. It's a digital instrument but it has a front panel like an old analog synthesizer and you can just sit there and play to your heart's content. A great instrument" (29:*B232).

III. LCD displays

"They {MIDI tools} are much less friendly. Are you kidding? You have to look at those little LCD screens. It's very hard to keep track of the full image of what is going on in the instrument. You can do it with a lot of practice but it's much harder than with the other instruments" (43:*B350).

"I didn't like the screen, I think it's horrible you have to work on that little tiny thing. In the beginning that was horrendously difficult. I never quite mastered any of the techniques to make it easier for myself. [...] You want to see what you'd left and you have to go down five or six layers and then remember where you'd left. It was ridiculous. You can't do it" (37:*A499)

"A lot of those problems have been solved, LCD displays are better but not so much better" (4:*C6).

IV. Hierarchical menu design

"[How would you compare the accessibility?] -For me personally? Not so friendly. And FM, even if it could bring a lot of glossy timbres, it's a really counterintuitive way to think about designing a timbre vs., say, subtractive synthesis. All of a sudden you're dealing with Bessel functions and sidebands that split up like this, whereas with the analog synthesizer you've got a filter, you really hear. You turn a knob like this and hear the spectrum going up and down. I don't want to diss MIDI. It just wasn't right for me at the time" (1:*A220).

"[MIDI] hardware like DX7, their interfaces pretty much suck, most of them, their panels are really small, it takes awhile - the style of jumping around the menus, I don't like it very much" (27:*B100).

"They {MIDI devices} all have little cheesy display panels and you have to cycle through all these little steps to program them and I don't like doing that. [..] Maybe it's a side effect of the design of MIDI" (31:*B400).

V. Absence of direct physical control

"There is no way to get an external signal into those instruments. Those instruments are closed worlds onto themselves. Those instruments were built in response to what MIDI had to offer as a language and that language was built around a commercial popular idiom" (29:*B45).

"I found the Synclavier very easy to use, you got instant feedback of the values you input with a simple turn of the wheel. I found the Yamaha DX7 to be a pain because you had to work with operators and algorithms in a fixed architecture The Synclavier was more fun, you could put an envelope on your harmonic structure (FM) as well as the amplitude, or you could do additive synthesis. And you could work with infinite temporal segments as well. In general, I find the analog instruments more accessible, where your results seemed more directly a result of a physical input (i.e., plugging in a patch or turning a wheel, etc.) The issue for me was really that of having to work within or to be free of a fixed architecture" (16:*add3).

VI. Uniformity of compositional setup

The same feature once seen as beneficial[86] can also be detrimental to unconstrained thinking. The lack of a standard among analog instruments fostered independent solutions to compositional setup and multiplicity of environments, whereas MIDI tools often work within the same mindframe.

"I still find the structure of MIDI tools very constraining because it's somebody else's conception of how music goes, not my conception. I've always thought that interface has a strong musical component to it but you design an interface for something, you're essentially telling somebody how you think music goes. If you look at any commercial software packages, I've never been able to use that because as soon as I start to use them I feel as if I got somebody else's musical head on my shoulders. That's why I write my own software" (24:*A435).

The very existence of limitations set by the manufacturer is a limitation in itself. The composer unwilling to submit to these limitations finds the solution in choosing an alternative setup model.

"What drove me to the software synthesis is generality of the tool. I don't have any limits [there] but myself. In the synthesizer using MIDI you are limited by the number of voices that will all be playing at the same time, by the amount of control information you can send real-time through the MIDI by the synthesis method that the manufacturer chose to implement, by all the design compromises that the manufacturer had to take to make that reasonably priced, by all the software design issues that the manufacturer had to compromise on to use a cheap enough processor, by all design compromises that the manufacturer had to make to make the instrument usable by your normal rock band because that's where the money is coming from. In modern instruments I don't really have sophisticated envelopes, in fact you'd usually have 2-3 segment attack section and 2-3 segment decay section and that's about it. What if I want to make a 16-section envelope? Some of them can do it, some of them can not. It changes from synthesizer to synthesizer, some of them are easy to use, some of them are hard to use. But it's all compromises. If I'm doing tape music, why use that if I have in a software environment something that I can shape the way I want" (33:*B190).

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[86] See Chapter 5.2.1, section IX.

VII. System exclusive

> "What I disagree with is the concept of system exclusive. I know why it's there and I understand it. But that system exclusive stuff to me is the stuff that is interesting. That's where the real interest of the instrument lies. I would make it easier to get at. But again that's a software problem, it's not a MIDI problem. With MAX you can do all that stuff and that's why that's my language of choice right now" (29:*B550).

> "Getting the sysex {system exclusive} information out of the Yamaha was like pulling teeth. Once we got it, we could start writing our own libraries [of sounds]" (29:*A520).

A long letter by Nelson published in the Spring 1986 issue of CMJ described negative experiences of dealing with system exclusive information (and Yamaha customer support for that reason) and disclosed much of that information to the readers of CMJ (Nelson, 1).

VIII. Lack of traditional analog devices and effects

> "It wasn't so much MIDI as devices' limitations. For example, the Lexicon PCM-70 [is] great, I can filter sounds with comb filters but, for example, I can't shape the spectrum more than just giving it a low-pass whereas on the Samson Box I could have added any kind of filter that I wanted to give it {the sound output} more of a spectral contour. I could have a different instrument contours, apply that after the filtering, to give it more of a sound, a particular format, or something. Well, on Lexicon I can't do that. Those were the kind of limitations. If it had been able to do that, I would've been able to control that with MIDI just fine. So it wasn't MIDI that was the limitation, it was the device itself" (31:*A446).

For example, *ring modulation*, a postulate and a cliché of electroacoustic music in the 60-70s, was difficult to implement into a digital synthesizer (aliasing problems).

> "It wasn't MIDI, it was the response to MIDI which was the problem. All of a sudden you could not buy a synthesizer that would let you ring-modulate something. There are no ring modulators on DX7" (29:*B45).

IX. Channels

> "I went through a certain amount of trouble with MIDI because things are not really addressable, you just have these channels and they are broadcast. You really should be able to address a certain device. You should be able to connect all your MIDI synthesizers together and say that 'these notes only go to that synthesizer' without saying 'don't listen to these channels'. So, that's kind of pain but besides that it's just more computers, more wires. MIDI synthesizers are complicated because they are parallel processors but they are also good because they are parallel processors. With parallel processors you can get more done than you can with the single computer" (32:*B460).

X. Lack of synthesis compatibility

> "MIDI instruments are only compatible in terms of performance control. They do not address the compatibility of synthesis algorithms at all. All MIDI does is deal with performance information. [...] With MIDI it's possible to take 25 different brands of synthesizers, keep them all synchronized with one another" (29:*C345).

XI. Keyboard-centric paradigm of design

Keyboard controlling has been connected with the development of synthesizers from its early, Telharmonium days. That instrument was followed by Ondes Martinot, an electric organ, WelteOrgan, Mellotron and others. "Once the synthesizer had become associated with the organ keyboard in the public eye, the inevitable inertia of success followed" (Rothstein and Metlay, 73). As a controller, the keyboard was easy to recognize -- the piano and organ (acoustic and electric) have been used for home amusement, music instruction and church services for centuries.

> "A lot of music [before MIDI] was already keyboard-centric. People start out with piano lessons, people start out learning notes on scales, people start out learning five-line note paper -- all basically dividing the world into 12 equal steps. MIDI was responsive to the existing situation" (15:*A362).

A large number of pre-MIDI commercial synthesizers in the 1960-80s (especially those geared towards popular music market), both digital and analog, were keyboard-controlled.

Besides easy recognition, the keyboard, as a set of keys, is easy to use to switch values other than pitch. Non-keyboard devices (Theremin, Buchla, others) did not enjoy the popularity keyboard-controlled instruments did. "But the keyboard remained the means of selecting event start and note pitch and gradually evolved into the form we see today. The pressures to produce an instrument that could be triggered reliably as well as provide a pitch reference recognizable by some large percentage of ordinary musicians resulted in the vast majority of synthesizers being controlled by keyboards." (Rothstein and Metlay, 74) The positive sides of keyboards described above are its negative sides as well. The fixed-value key concept proved a major obstacle to exercising continuous control over musical ideas achieved previously by either software synthesis or analog voltage control.

The following excerpt illustrates how the terms and concepts coming from the keyboard experience led to confusion and misunderstanding in how to apply them to non-keyboard functions.

> "You had to translate, for instance, *velocity*, all these names that were created for a particular thing and then try and figure out 'Is that what I want or something else?' First, they'd have a controller number associated with the *breath control*, now they just have controller numbers that you just associate with it. At first, you had to say to yourself "I can use *breath control* or I can use *aftertouch*, or I can use something to do this that I want it to do whereas if they'd been neutral to start with then I wouldn't have had a problem."

> And that was because of a very big misunderstanding, or maybe, it's just a cleavage between general uses of, say, keyboard player and the composer where keyboard player knows what aftertouch is and uses it all the time and I know but it never occurred to me to do with *aftertouch* what I was doing with the envelope follower, I never would think that that's what it was. Or *key velocity*, how's that associated with clicks of my tongue, you had to translate. A lot of this stuff was just ... foreign. Partially because it was [made in] a foreign country and partially because it was designed for keyboard players. [...] It {understanding} wasn't immediate. As soon as I could neutralize the concepts, then it was pretty easy. To a large extent, the early MIDI instruments, except for the Yamaha, were not terribly friendly to that neutralizing factor. Now I think all of them do that, you can configure them any way you want. But in the beginning that wasn't really thought to be the way people were going to use it. We had to find ways to break this code, get into the system exclusive, that was so complicated, giving the codes and all of that stuff, this was a hard thing to break into from my standpoint. [...] For those of us who were already doing ramps and all sorts of things that were controlling things in time and space, suddenly having to translate into black-and-white keyboard, not only was it not easy, it seemed wrong to do that" (21:*A530).

Numerous attempts to introduce alternate controllers through joysticks, foot pedals, aftertouch, modulation wheels, and breath and wind controllers, have been only partially successful. Nowadays the keyboard remains as the sole means of control in the absolute majority of electroacoustic synthesizers and devices. It led McMillen to conclude after more than one decade of MIDI equipment that "the success of alternate controllers has been less than overwhelming in the history of electronic music. The predominant controller for electronic music synthesizers has been the piano or organ keyboard." (McMillen, 47)

XII. Software data inconsistency

Yavelow's survey of Mac music software [Yavelow 1986] highlights the problems caused by working with different software packages caused chiefly by lack of standard in the area as well as the voluntary decisions of the software developers. " Of primary concern are the types of MIDI data recorded by the sequencer software. If a program does not record such basic channel commands as keystroke velocity or pitch bend, we are forced to exclude these items from our musical vocabulary when dealing with that program. If it records these parameters but does not allow us to edit them, we are equally at the mercy of our software. [..] Resolution of recorded data can also impose distinct limitations on our musical expression. Rhythmic resolution is one area in which there is no standardization. For example, Mark of the Unicorn's Performer software divides each quarter-note into 480 "ticks" while Southworth's Total Music is limited to 96 divisions of the quarter-note" (Yavelow 1986, 17).

These contradictory settings also affect the compositional techniques when applied to the editing operations. When the scope of editing is limited or a certain detail is impossible to reach, the conceptual model of the piece is challenged and often forced to change. "Setting arbitrary priorities on musical parameters and on the restrictive concepts such as track, channel, region, and note can force one into composition methodologies that are incompatible with one's musical

aesthetics. Some programs make it very easy to apply edit operations to an entire track and much more difficult or even impossible to edit a selected region or note" (Yavelow 1986, 18). Such constraints are not caused by the flaws in the MIDI protocol but are due to the design problems of the device.

5.3 Social Benefits of MIDI Equipment

Nearly 4 out of every 5 composers (79%) found the social access to the tools much better with MIDI than with pre-MIDI equipment. Only 1 out of 33 composers who answered the question viewed it differently and 6 composers (18%) did not perceive any significant change.[87]

Table 12. ***Social Accessibility of MIDI***

	Better	Worse	No change
Social accesssibility of MIDI devices as compared to pre-MIDI ones	26	1	6
Percentage	79	3	18

Although the scope of the question "*How do you compare social accessibility of MIDI vs. pre-MIDI equipment, based on financial accessibility, general vs. limited access to the tools? (better/worse, please explain)*" was rather narrow, the responses suggest a wider range of social benefits than what was originally expected.

5.3.1 Affordability

When compared to pre-MIDI tools, ***financial accessibility*** is commonly cited as the main social benefit of the MIDI generation of music-making tools.

> "As for 'financial accessibility, general vs. limited access to the tools,' that's easy to answer. MIDI equipment has been considerably more accessible on all counts. It's cheaper than pre-MIDI equipment, it's a universal system (in terms of implementation), and I suspect that it's available in some form to almost everyone who wants it. This is because MIDI equipment is mass-produced and computable. Everything before it wasn't, at least to the same degree, even some of the cheap voltage-controlled systems" (6:*add4). "What was important was affordability. That did make a difference, the fact that I could buy one of those things. In those times the dollar was very expensive in XXX, one of these things was very expensive in terms of salary. You had to spend here, let's say, one-two salaries to buy those things. Maybe down there, you had to spend 10 or 20 to do the same thing. So when affordable digital synthesizers appeared, that made a difference" (33:*B595).

[87] Table 12.

"In fact, a lot of what I did earlier was resonant filters and things like that, so it was very wonderful to have a very powerful devices come out very early on and that was reasonably affordable, it was $2000 at the time and still is and that's pretty inexpensive to be able to do so much" (31:*B353).

"Sounds are cheaper. You can have more voices simultaneously for less money than what you did before, for few hundred dollars you can have dozens of sounds playing simultaneously" (30:*A260).

"What people were doing was building these very big, expensive devices, like the Synclavier that could do everything and nobody could afford, but if you have MIDI, all you have to do is build little inexpensive boxes and you can just pick and choose and buy just what you need for a much, much lower cost. I think that's the most important part, affordability. You're winning time and you're winning the cost" (31:*B305).[88]

The level of affordability, generally agreed (see percentage above) as higher, was still not high enough for all composers:

"Well, in a way better with MIDI, as the prices came way down with the advent of the DX7. But at the time I still couldn't [afford], and I knew few musicians who could, afford to set up my own studio" (16:*add5).

Several opinions contradict the assertion of better affordability coming with MIDI tools.

"It wasn't MIDI that made that revolution it was the transistor in the pre-MIDI instrument that did that. Not much happened at all not because of economics, I think in terms of economics it was cheap enough and I don't think it got cheaper. it stayed around the same. I think what happened more is that it was more accessible [because] you could make 'normal', more traditional music easier and more people were more interested because of that. I think pre-MIDI didn't lend itself as well to tuneful music. When MIDI stuff came along, it reached not only the electronics buffs but all the other people who were more interested in more traditional music. So it has become more widely used but not because of economics" (21:*B192).

"Pre-MIDI there was affordable synthesis equipment (mostly analog), and post-MIDI came the dramatic explosion in commercial digital technology of the 1980s (which did not depend on MIDI to take place). I'd say that MIDI did not play such a great role ..." (7:*add4).

"In the 80s MIDI [equipment] was expensive. It was difficult to incorporate it into my projects" (8:*A206).

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[88] In addition to the excerpts in the chapter, please see Appendix D. It contains two detailed testimonies of composers who started their career independently and continued to work unassociated with any academic institution during early MIDI years. The similarity of their experiences is striking as they worked very far from each other geographically. Both stories show that working independently involved extensive custom instruments since pre-MIDI synthesizers and studio computers were out of reach and even then MIDI equipment was barely affordable.

5.3.2 Democratization

Democratization of electroacoustic music (obviously only compared to pre-MIDI conditions) was another positive change brought about by the change in tools.

> "My feeling [about MIDI] at that point and my feeling still is that that was a great thing because it resulted in democratization of computer music. I'd been going around giving talks of the work I'd been doing and, essentially, I was using a million-dollar computer and obviously thousands of dollars worth of CPU time, so I was talking about things nobody could do on their own. Then for the first time people could set up their own labs and studios. And that was, in fact, what happened -- a huge explosion of studios and systems. [...] So the thing I liked so much about MIDI, and I still do, was that a whole lot of people of, all of a sudden, started to do things for five thousand dollars. For me that's the primary benefit of it, all kinds of people can do things" (24:*A135).

Roads recognizes the same social effect in his 1989 text: "Activity in computer music has spread far beyond the laboratories of academic and research institutions. The technology is now so accessible that virtually any musician can set up a home studio for research, composition, or playing. We see more and more computers on stage in concert halls and in nightclubs. Sophisticated digital music systems for live performance are not farther than the local musical instrument store" (Music Machine, Preface xi).

The community has expanded as the access to the tools to produce this kind of music has been given to the musicians not associated with an institution (as is the case with the absolute majority of composers interviewed). As it has been mentioned earlier, few composers worked independently at the time of the introduction of MIDI. In order to survive the evolution of technology and also be able to continuously produce new works in the volatile performing situation (particularly in the US), one had to be associated with an institution.

> "From my standpoint, it was necessary for me, as an *itinerary [-based]*, as opposed to an *institutionally-based* musician, to have a flexible and portable setup, the one you can take virtually anywhere, not when you need a truck and resources of a university to get going. (*240) MIDI was designed to work with slow cheap machines like the ones that were available to most people. And those were the ones that if anyone was using [something] in live music, those were the ones they were using and everyone else put things on tape. That was the state of the art in '83-84" (15:*A215, *A240).

> "What MIDI really did is democratize music and spread it out much more. it allowed more and more people to set up commercial studios and make money off music because you can incrementally build up systems. By making everything compatible people could just have a wider choice" (30:*B53).

> "The very good thing about the MIDI generation [of equipment] is that many people use the computer. The computer is no longer a taboo, no longer a strange machine doing strange things residing in very few strange places but is more commonly available. This is a beneficial effect. The other good effect, people can access the machine and can play with it and that's good, people should try that out and see what they can get out of that" (17:*B295).

A very important social benefit of MIDI cited here is better representation of musicians coming from underprivileged backgrounds as well as from non-Western musical traditions into the electroacoustic music community. This comes as a result of better affordability of the tools and diminishing connection with academia.

> "I was never, except until for a very brief period in the 1980s, really privileged to hang around computer music studios and get the benefit of all that. For a number of issues, mostly involving class and race. What I find is that if we don't consider those issues and evaluate the conduct and choices, we miss something" (15:*A215).

> "It {MIDI} made it possible for more cultural inclusion in terms of kinds of music expressed using the computer. I think that was a really big change. The tendency, particularly with so called 'computer art music', was in importing into this domain of software ideas actually coming from high culture European approach to using computers in the arts. Because of that it seems that the situation you have today [is] you see computer music could be more culturally inclusive, could take better kinds of gender issues, could deal more honestly with race and so on. [..] MIDI brought in a lot people who would otherwise not use computers, a lot of those people were not white and did not come from privileged backgrounds. That would have to make a change in how people consider the ways which computers are used. One problem that it made was that it de-mystified computers, and it de-authorized a lot of people who had used computers as 'mystic authority'. I think it's wonderful as far as I can see!" (15:*B400)

One of the composers pointed out a conflict between the commonality and mass appeal of MIDI tools and the elitism of electroacoustic music largely confined within the walls of academia.

> "MIDI, from its beginnings, has been largely negatively viewed by the academic elitists. The usual reasons for this have to do with the limitations of equipment and software, but, I suspect, that the "commonness" of the equipment has a lot to do with it. When we at XXX decided to go MIDI and get rid of our Buchla stuff (both analog and digital) a composer complained to me that now we'd have studios "like everyone else." Commenting on the necessity and functional importance of uniqueness, I retorted that that's why all of our pianos had 89 keys" (6:*add5).

Inexpensive MIDI devices had a lot of positive musical applications outside of producing art or commercial music. Those included use of MIDI synthesizers and software for education; online conversion of classical scores into MIDI files and data, and various devices for home amusement and learning. "A vast amount of musical activity by the people of our culture is undertaken for the personal edification of themselves as individuals or their social groups. The evaluation of musical works for their high cultural longevity is an irrelevant activity for these persons. Their musical activity has its own legitimacy, even if its meaning is limited to a relatively small social sphere. The people need rich and inexpensive resources for their musical activity. This is an important point and should not be overlooked by those primarily concerned with 'high' art" (Rosenboom in Symposium on Computer Music Composition, 55).

5.3.3 Concert Organization

Commonality of MIDI devices due to their wide distribution was to the advantage of touring performers, particularly in troubleshooting equipment problems.

> "They {Yamaha TX7s} were not multitimbral, they were the first generation of [MIDI] synthesizers but I always used them because we traveled far and light and I was afraid that I'd be somewhere in the hills of New Zealand and not have a synthesizer, break a wire or something, have to replace it, so I wanted something always more common, for one thing. For another thing I invested a lot in developing sounds for those synthesizers and they were light and easy to carry around. So I used them until recently" (30:*A284).

Use of a MIDI device as a ***substitution*** for an acoustic instrument could save the extra costs and rehearsal time when organizing a concert.

> "It {the use of SY77 in a piece for a predominantly acoustic orchestra} was like a security exit that if I were to need something and I wouldn't be able to write with 104 other instruments. [...] May be all of that could've been [done with acoustic instruments] - you can make glissandi on bells when you put them through water and things like this but I always went writing for a big orchestra, I wanted to be quite practical because it's a mess anyway, there was so little rehearsal time" (20:*A400).

> "[Explaining the use of Yamaha SY99 synthesizers for writing film music in the 90s.] - Practical reasons. To make the same music with live instruments, at least, to hire them, to record with them, my fee would have gone there. I didn't want to invest myself. I think it also suited the aesthetics of the films, one of them was completely synthetic images, these kinds of sounds suited it quite well" (20:*B159).

Portability was another benefit for organizing concerts.

> "MIDI has certainly made it easier for me to travel because the equipment is light, but that's not what you're looking for. I used to lug around three heavy suitcases and now when I go to Europe to do a concert all I need to do is carry a disk because I can use any old Macintosh computer that I find on the spot and I can borrow a friend's synthesizer. And it {the music} is exactly the same." (30:*B55)

> "The other thing, in terms of access, was the portability of it, the fact that you can bring it on-stage, this kind of gear. When I started performing particularly improvisational work with cello, pitchtracker, Macintosh and some MIDI synth - that's accessibility." (13:*B225)

Limited ***performability*** of electroacoustic pieces due to the quick progress of instruments has always been a problem with electroacoustic music. The abandoned or superseded steps in the evolution of instruments have meant extinction of these instruments and the end of performance of the pieces written for them.

> "This piece written for Buchla is no longer performable... The problem is after the composition the machine disappears and you have to replace it. It was the same thing with 4X. To transcribe "XXX" from 4X to the NeXT workstation, that [took] more than one month, one month and a half. It was very difficult." (3:*A446)

MIDI on one hand was another step in this evolution making performances of pre-MIDI pieces very unlikely. However, within the MIDI environment, the interchangeability of equipment, MIDI files commonly understood by various brands and devices, significantly raised the chances for the performance, or the whole piece to be redone using another MIDI instrument.

5.3.4 Personal Computer Music Studio

As it was mentioned earlier, two-thirds of the composers interviewed during the course of the project used computer environments for composition in pre-MIDI years.[89] The possibility of setting up adequate working conditions for electroacoustic music composition outside of the institution-based electroacoustic studio fostered flourishing of the home-based MIDI computer music studios, a concept hard to imagine before MIDI due to the excessive costs of equipment. Such studio would usually be centered around a single computer and would also include synthesizers, mixers, voicebanks, samplers, effect boxes, mixers and the tape recorder. The whole process could be digital or mostly digital with the final stages (mixing and recording) done in analog.

> "As for accessibility, MIDI has been extremely important in bringing electronic musical instruments into the home and small studio -- this was a big part of the commercial motivation of course. In my case, prior to 1987, I had been given extensive access to the XXX {an electronic music studio}, even beyond my completion of graduate school there in 1985. By 1986 or so, I saw my access ending and knew that I had to find a way to continue my work, preferably at home. I purchased a DX7 and ESQM, then a TX802, DMP7, Voyetra 8 and software for the IBM from Voyetra and others. These forced me to find new ways of getting what I wanted musically, being very different from the Buchla I was used to working on. But the very fact that one could do this kind of work with software sequencers and modular synths *at home* was a huge leap in terms of accessibility and the limitations that came from the fact that these MIDI instruments were designed with "traditional" music making in mind now seems a small price to have paid" (28:*add2).

> "Before [MIDI], there were few places where you could do this kind of work. There were research environments not nearly as available. Sometimes [with] the work I needed to do, it was important that I would be able to do it off the site of the studio. I've always been fortunate to be near the studio at CCRMA or somewhere else. There have been times when working apart from the studio, remotely, was an important item" (13:*B225).

5.3.5 Negative Social Effects

The change of tools (*'retooling'*) which necessitated spending considerable amounts of money on the new set of instruments is held responsible for a negative social phenomenon illustrated by the following example. This independent performing group could not afford such an undertaking and was eventually dissolved.

> "[Why did your ensemble of analog synthesizers disappear with the arrival of MIDI?] - Part of it, I think, was financial. To use MIDI one had to buy a MIDI instrument. Well, not

[89] Table 1.

everybody was able to do that. We'd spent several thousands dollars each in buying all this analog gear. All of a sudden here comes this digital revolution nobody could afford. The whole rationale behind MIDI is financial. MIDI was developed because all the kids that had their garage rock'n'roll band that could afford to buy a synthesizer had done so. The market was almost dead. Synthesizer sales were dropping because everybody that needed a synthesizer or could afford one had purchased one and these things were expensive. [...] So everybody had to retool. With the retooling the ensembles went away" (29:*B95).

According to one of the interviewees, introduction to MIDI has had a profound negative effect on the ***exchange of research information*** within the electroacoustic music community. This phenomenon is seen as part of the community's adaptation to the technological revolution in the tools.

"What we've got happening here now, which for me is a part of a very detrimental part of the whole field, is we've got a commercialization of software that is out there. We have years of people that have been in large research labs with every facility available for them to dream to design the ultimate composer's interface, all of a sudden seeing that someone out there in the field was able to market something and make something off their research. Immediately what happened was everybody became close-mouthed. Nobody wanted to share the research any more. Everybody wanted to patent, to downscale their packages to make something marketable to sell. For me, that killed the field! It killed it completely. All this wonderful research of this group coming together to design the composer interface, having the System Development Foundation fund millions of dollars to MIT, to Stanford, to San Diego to come up with a common interface, to come up with a common approach. All of that went out the window. Then, I mean before MIDI, people were still talking to one another, sharing their research, it wasn't worth anything, nobody wanted it, it wasn't sellable, it was for us. All of a sudden it became marketable, there was a dollar figure connected. So all these wonderful researchers that were developing all these incredible things for people like me to use, they started to downscale their own work. They started worrying whether their interface will work for rock'n'roll musicians that wanted to write 4/4 music and wanted to be able to print it out in Finale. What did that do for me? Nothing, absolutely nothing" (14:*A222).

Carmine Bonanno of Octave-Plateau Electronics, a smaller MIDI manufacturer, apparently agrees with the respondent above describing the situation in the instrument manufacturing industry after introduction of MIDI. "It's symptomatic of the music industry that people don't want to talk to each other. That frightens me. ... it's like people are so protective of their own ideas that they don't want to talk to you" (Carmine Bonanno in Milano 1984a, 60).

Commercialization of the field is also addressed by another respondent. "All that stuff {MIDI software and hardware} is being imposed on us because of the commerciality of the media right now that MIDI has brought about. It's not MIDI's fault but it's in response to MIDI" (29:*B440).

Chapter 6

The Impact of MIDI on the Style and Methodology of Electroacoustic Art Music Composition

6.1 Changes in Musical Style

The tools for composition are inevitably linked to the conceptual model of the work through the methodology employed for the realization of the composition. Tools may "require us to conceive of our musical data in ways that are not acceptable according to our customary methodology. On the other hand, the possibility exists for viewing our musical material in ways we may not have previously considered" (Yavelow 1986, 17).

The following excerpts from the interviews do not represent the entire spectrum of changes but only the ones that happened to the composers interviewed in the course of the survey. Nonetheless they help establish the connection between the application of certain tools and the musical output.

6.1.1 Composition

The use of all-digital tools has brought major changes in the routine of working on a piece. Digital technology comes in to help at all stages of work. "The machine comes in at all points, from designing the score, generating it, to designing the instruments, mixing them into orchestras, orchestrating, and rehearsing the composition until it sounds "right"" (Laske 1985, 7). At the macrolevel of working with music, digital technology allows the user to shuffle, analyze and edit segments of the piece and finally store the result. The entire technological routine may never leave the digital realm.

I. Acceleration of compositional process

"First of all, if I wanted to hear it, I could hear it and I could hear it pretty clear. It allowed me to think faster. [Could you do that with an analog synthesizer?] - Oh, no. You wasted a lot of time. First of all, to get the damn thing to be temporarily correct was absurd. No, I wouldn't want to go back to that" (15:*A400).

"[On the differences between his music in early 70s and late 80s] -I didn't change the material so much then, I'd use more time in creating the material. [...] And then I could use this material and change it and make it more personal, give my personality to it. [...] In early 70s I'd use much more time in preparing the material I should use. And, of course, I could change it afterwards and I did change, but [then] there was also much [more] of the editing of the material. But in the late 80s and in the 90s, I go much further in changing the original material, so far that you often can't recognize it" (5:*A397).

II. Reversal of work order

"The other thing I don't like about it is that very often for me the way I like to work is to begin with some sort of timbre. My experience with MIDI is that the whole process is reversed. Very often they set up some compositional framework and then the last step will be assigning timbres. For a while I'd take "XXX" [the only MIDI piece] out to different places and see what synthesizers they had trying figure out what presets to use. I always found that uninteresting, counter-productive. [...] What I don't like about is the location of your reaction to timbre in the compositional process. For me the composition proceeds from reaction to timbre. The timbre is not a parameter, timbre is part of the entire package of things, that have to do with the sound. The piece evolves from reactions to the spectral things. The piece evolves from listening to some speech, or listening to wind in the trees, to listening to something else and the music evolves from that. The thing that MIDI encourages you to do is to invert that process" (24:*A190).

III. Closer approximation of performance during composition

"[What changes has MIDI brought into your style?] -The fact that I have less thinking to do and I could do more music. It really allowed me for the first time to be a performer, to not only be someone on stage trying to divide attention between being half an engineer, half a composer, half a musician. [...] It's interesting to see that computers could help you with changing the course of the piece as a composer during the performance. You realize that in that specific situation with those specific people you can improve the quality of the piece. This is something that has not ever been possible even to think about because you can't just go around and tell the musician to do or play something different or give them something different in the score and just play this... it hasn't happened very much. This now is a possibility" (23:*B250).

IV. Change of performance setup

"MIDI killed the ensembles. [...] The instrumentation changed, we wanted the better sounding instruments but it forced us into being better keyboard players. That was the end of the ensembles. I've never thought of that, that's curious. At that point I started writing pieces that involve interactive electronics with signal processors" (29:*A532).

V. New compositional techniques

" [I] use MIDI to start and stop sequences. [At] the first level you need a pitch-to-MIDI converter to [...] take the pitch [of an acoustic instrument] and convert this into MIDI information in order to trigger the sequences that are stored on the hard disk. This way you can create music that is a little bit interactive using at the same time instruments and tape, but it's a tape cut into little fragments that can be superposed, you can have several computers and run several processes, for example, several ProTools, DigiDesign, whatever you want, you can use several channels of MIDI information to start and stop the playback of the material that was already composed" (44:*A460).

VI. MIDI as input help for algorithmic procedures

"What I could do then is to record certain sequences, put them in performance and then have them synthesized out of real-time with non-real-time synthesis. In addition, for example if we don't like, we could do an arpeggio on this keyboard, which I didn't have to map to the chromatic scale afterwards. [So you used it {MIDI} as a help for input?] -Exactly. [But the final result will be algorithmic, non-MIDI?] -Produced in real sound. Yes, but it works very well. I have these pieces that are for a complex array of sounds which are tape [pieces] but with the suppleness of the phrase" (38:*B130).

VII. Parameter change bottleneck

"If I have 20 notes and I want to control them all at the same time. I can not because of the way I have implemented the program. This limitation of bandwidth -- I can't wave the baton around fast for the controlling device because things are outdated in discrete time interpreter. You will hear a jump in some controlling parameter, a sudden jump in volume, a sudden jump in pitch, because I just can't send enough information through this tube that is MIDI. If I could, no problem. I compromise by throttling back my style of playing. That's a performance issue, [...] you know what you can do and what you can't. I work within those limits. Sometimes I have to compromise and I can not do fast changes of parameters" (33:*C258).

VIII. Higher complexity of tasks

"It {MIDI} opened up the potential with a lot of new ways of dealing with sounds and opened up a lot of other operating conditions too: you can do certain operations in speed and complexity within the use of these tools that you couldn't on your own. [You mentioned something about the number of voices and complexity of texture?] -Sure and also you could do certain things rhythmically that you couldn't play" (37:*B460).

IX. Better zoom on the details of the composition

"I think the work's changed, it's much more precise, there's more reflection. I take the time to hear and hear again, and if I make a transformation, I can go back to when there was no transformation and compare them {those two moments}. I think it was harder before and I wasn't thinking about that" (22:*B20).

X. Overly facile examination of the material

"They [MIDI tools] are much easier which is both good and bad. Commercial software firms made it look like you are just "doing music". If you are doing your notation program and you pop up your standard music notation and you send it out to a synthesizer and hey! wow! I've done my own piece. You couldn't do that in the old days, but because you couldn't do that, it forced you to think about the whole situation differently, you had to write software to actually respond to whatever note event you started up at a particular time. You'd say "start an event X", then you had to write a piece of software code that said "When you get a note X you do such-and-such " It could be what you might think of as a note, a phrase, a whole piece, anything that you wrote that code to do when it received the command to begin at a certain time. That process of reevaluating of what it meant to produce a sequence of events, to produce a piece was very valuable. I think people are missing that when they are handed too many tools [..] and they don't examine the process sufficiently.[...] (*B255) Because I started with a very difficult system I was in a habit of evaluating why I was doing what I was doing. If I had started with a very simple MIDI system, Finale, Macintosh and DX7, I probably would've written music very similar to what I wrote for instruments, just changed the timbres a little bit, whereas getting away from that, it prompts me to analyze all the aspects of music, of what the computer and the electronics can bring to those elements" (34:*B205, *B255).

XI. Closer resemblance of traditional method of composition

Taking an analogous chart done by Winsor for all computer-assisted composition as a model (Winsor, 26), let's compare steps in traditional acoustic and MIDI composition.

Traditional	MIDI
1. Conception	1. Setting up environment
2. Sketching	2. Creating notelist
3. Play at piano (real-time)	3. Trying out with MIDI (real-time)
4. Revise	4. Revising notelist
5. Final score	5. Final MIDI file (notelist)

For example, the following excerpt, reminiscent of acoustic composition methods, shows implementation of the orchestral paradigm into composition/performance of a MIDI piece.

"It was a lot simpler to me to be able to definitely say as a programmer 'I'm going to play this sound now and it's going to play for this long. I can count on a time between the onsets of this long, and I can count on that percentage of that sound being on.' And then I don't have to worry about what comes out, in other words, I can compose that part separately, I don't have to compose that part into the computer program. I can make a virtual player who's playing a set of virtual keyboards so I could conceptualize how many keyboards I want him to play. So at this standpoint the new systems that I'm using, they could've been conceived as being 64 independent musicians, who can group themselves and keyboards any size they want. I think I've just modeled an orchestral paradigm where I've got a group of instruments and I can figure them how I want. And I could off-load the part of it which I'm really not that interested in, which is how to craft theses endlessly changing sounds. I'm just not interested in that. I'm happy to leave that to people who know about that" (15:*A375).

6.1.2 The Role of Interaction in the Musical Process

I. Emphasis on interaction

"[In] pre-MIDI times there was no interaction between the instruments and tape. [In] pre-MIDI times we had tapes and a lot of tape because hard disk storage was very expensive at that time so we had to immediately transfer it onto tape. The mixed pieces - the pieces with instruments and computer-generated tape -- were done in this way, there was interaction in the hands of the performers but there was no technological interaction" (4:*A150). "I wouldn't say it's somehow revolutionized my thinking, it's more like [that] the pieces I write for this medium have more of these characteristics, a concern with interaction for one thing. An interaction has a lot of interesting aspects such as the ones I was talking about: permeability between instruments, new concepts of form that are kind of improvised, autonomous processes in the computer that you interact with - those follow from having interactive computers" (32:*A330).

"Going back to the beginning, I always just had a tape and instruments. I wrote a lot of works like that. More and more synthesizers came into platform. I would have a typical ensemble of let's say three synthesizers and three or four normal instrumentalists or singers during the 80s. [Why did it change that way?] - I found the tape alone too much of an infringement on the performance time and space, too much of enslavement of the performers to time which is fixed. I was reluctant to lose the hours of careful work in the studio where you shape sounds that you put on tape. With live performance you sacrifice so much of that if you transform in real-time or you did, (in the last year or two it's becoming so fast)" (35:*A345).

II. Real-time interaction with algorithms

"Nothing really changed in a fundamental way there except for the possibility of making this sort of real time explorations of algorithmic space. If I wanted to go through a vast number of behaviors of an algorithm, it's much easier to do it in real time than some abstract level of the algorithm whereas to do it in the fashion of the batch processed system then, well, you just have to turn out variation after variation and listen to them. It's more immediate if you can control that in real time" (13:*A330).

III. Improvisation: encouraged vs. restricted

"[Improvisation] is certainly an important part of that piece.[90] In general, no, I haven't done much with improvisation" (*A475). I really wanted in that piece and I think I succeeded to develop the kind of an improvisatory connection with some algorithm. I really liked the idea of algorithm as a generator of a musical shape. I think the piece succeeded more when it was improvising its own alphabet" (24:*A375).

"Improvisation. If you think of improvisation being spontaneous composition then I'm more interested in that [since introduction of MIDI]. [MIDI] allowed a real-time interaction with the computer so I became interested in how I can set up a system that'd make my performances larger than life" (31:*B60).

The following respondent expresses an opinion which opposes those above. "I used improvisation in my pieces a little bit more freely before MIDI because I became distracted by the precision of MIDI and didn't work with it a whole lot in the first few pieces that used MIDI. I think it had been a particular proclivity of mine that I got distracted by the precision and control when MIDI came along and left some interest in improvisation behind, temporarily" (18:*B190).[91]

6.1.3 Sound Generation and Sound Control

I. Note vs. texture (gestalt)-oriented approach to composition

"It makes the music (and I fight against this, but it's inherent to the system) more note-oriented. You hear a lot more of discrete repeating of onsets of sounds, in the way that you didn't hear in the earlier music. [Was your earlier music more texture-oriented?] - Yes. There was less of an emphasis on [the] discrete, note-oriented" (40:*A580).

"There was a kind of freedom and adventurousomeness in working with analog voltage-controlled systems that if you're working with any kind of computer music, or you're working with MIDI in terms of using computer, [...] there was a big difference. The result was that pieces, including my pieces, became much more event-oriented than they had been before. [...] My music became [...] much more pitch-oriented as opposed to being timbre-oriented. One of the things that now is very easy to do with computers -- which is to take sound A and sound B and interpolate between them -- is something that I worked very hard on in terms of the analog stuff being able to do what I called at that point 'linear-timbral transformations' from one thing to another which other people weren't working with. And that had to be accomplished in real-time. Those kinds of things sort of went out the window when I started dealing with MIDI. You are more concerned about working in the event-lists, stating all the specific information for each event and then worrying about getting an external hard [drive] to sound relatively decent instead of the factory sounds that everybody else was using" (6:*A330).

"When I do a MIDI piece I may be content to more or less use the sounds that are in the synthesizer with the few tweaks whereas when I'm doing a piece in software synthesis or

[90] The only MIDI piece.

[91] See Chapter 6.4 "Role of Improvisation."

real-time synthesis [... or], some other medium, like Music Kit which combines both, I might be more concerned with the details of the sound than I would be in a MIDI piece. In a MIDI piece I am more concerned with the pitch structures" (32:*A330).

II. Division between sound generation and control

"It {MIDI} produced a terrific division between the sound generating processes and the performer. It separated the two in a way that was not the case with the earlier hybrid instruments. With those instruments you could put your hand on the sounds almost as intimately and with the degrees of nuance and subtlety of a trumpet or a violin" (43:*A240).

III. Easier generation of notes

"My impression [of MIDI] was that somehow, all of a sudden, you produced too easily too many notes" (20:*A303).

"I took some steps forward, some steps backward. Generating very thick textures full of notes got real easy, sculpting sounds just the way I wanted got a lot harder. [...] For me there were some really severe tradeoffs, all the notes and more of it than I ever wanted to compose were instantly available if I wanted to compose them according to a time-line. If I wanted to compose according to interactivity or data flow it was not as powerful" (18:*B285).

The same observation was made by Tovar in his letter to CMJ in 1986: "Constraining a note to be described with difficulty beyond amplitude [velocity] and frequency [key number] seems to have produced a generation of music where quantity of notes seems to be preferred over quality" (Tovar, 7)

IV. Emphasis on control, but at the expense of expressivity

"In my first MIDI pieces I [was ...] compromising and paying more attention to control issues than signal generation and signal processing issues. I found that my range of expressivity was limited by dealing with closed hardware architecture. As soon as I had an opportunity to deal with the more open environment, I substantially abandoned MIDI-controlled generators and processors. Even though some other things were difficult to do, I found that gains in the all-signal processing environment like ISPW were much greater than the losses" (18:*B330).

V. Extensive pre-performance work to achieve continuity of sounds

"The pre-MIDI stuff very very rarely if ever, used the pre-recorded material, it was all generated on the spot because I was not as interested in tape plus instrument as in the performance. I was driven by a performer, therefore I had intended to work with either

the situation in which the performance sound is being processed, or it would be a situation in which various performing instruments are electronic.[..] After I started to use MIDI [...] more effectively myself in the performance, I had a different relationship to making the sound have the kind of personal nuance that I wanted than with the other (pre-MIDI) instruments. I had to make those nuances more ahead of time than on the spot. [...] Here is an example, I had to work with the trio [...]. Many times we had performances in which I would interface everybody to some electronic system that was using MIDI. The way in which I had to rely on making the sounds really have the personal nuance and detail associated with the performer on stage had to do with being very clever at figuring out how to make pre-structured samples mix, transition, crossfade, or combine with each other according to something that somebody played. I didn't use much tracking, envelope following. [..I was] trying to figure out how to make a sequence of 5 different sounds, that are all pre-structured because they are samples, sound like one sound being varied. If I play [several notes] getting louder on the keyboard, the software might say 'Start playing the sample, then crossfade it to this one, and then play these two together, and then mix this one, and then come out here..' - but I am trying to trick the listener into thinking that that's actually one sound being continuously varied. In the old analog you could make one continuous sound continuously varied but in the MIDI world you had to be very clever at figuring out how to pre-structure these sound worlds so it would seem like continuous control" (43:*A478).

VI. Extended possibilities for creating and manipulating scores

"There are two important aspects in which MIDI has a principal role: one is to make MIDI files to make scores that you can manipulate in the computer benefiting all different manipulations using the computer that you can't do by hand. You can use these to make a final score for the instrument. This is one important point that was coming with MIDI. It's much more easy today to write scores and manipulate score material since MIDI" (44:*A75).

VII. Keyboard-oriented approach

"All of a sudden I became very keyboard-based because that's what instruments were. Still are! We talk about keyboards and we'd have this silly classification called alternate controllers. Back then we didn't have alternate controllers, and the only way to get information into the instruments live was through the keyboards and pitch wheels and all that sort of stuff" (29:*A525)

6.1.4 Timbre

Throughout this study 'timbre' is understood as "the quality of tone distinctive of a particular singing voice or musical instrument" (Webster's Dictionary).

I. Use of more voices simultaneously, layering

"I was using more layers and more voices after they (MIDI tools) were available. [..] I was always trying to make things that are very clean and articulated, so, I may be layering more since MIDI because there are more voices available" (28:*B50).

"[The impact is] only to the extent it increased the palette, on other words, if I can bring more devices into a sound, or a sound cluster, texture -- sure [there was influence]. Literally, add on, make my orchestra larger." (37:*A600).

"[Compared to pre-MIDI, do you have a higher complexity of texture with MIDI?] -Yeah, to a degree that's true. [Complexity] in timbre, complexity in interaction of voices. [Is it complexity of the envelope, or of the number of voices?] -Both. You can certainly alter the envelope in ways that you never could in any other way. I certainly arrived at the attack of the sound in ways I would've never done acoustically myself. Particularly when you can see the waveform and make adjustments, add or subtract elements of harmonics to a given waveform electronically. That all could be done, I could've never done that before" (37:*B485).

"[Has the number of voices changed with MIDI?] -Yes. More. [Do you have more parts simultaneously?] -Yes, that's what I want to have but sometimes I can't have it because I don't have enough MIDI interfaces or MIDI channels, or MIDI voices running at the same time. I usually use thick textures, more like symphonic sound, in a way, not just a tiny sole instrument" (33:*B367).

II. Use of samples as timbres

"The software part transfer [was successful]. The hardware part was more of the problem, because I still liked acoustic sources and instruments in my pieces and often I'm not using synthesis directly. Eventually I went to samples. A lot of sculptured instruments I sampled and I use them now in that form. So that was the transition that happened to me: from the sculptural instruments that I played, eventually I sampled those instruments" (40:*A185).

"In this (MIDI) way I was starting to make music using natural instrumental sounds. Instead of using oscillators in the declarations of the instruments, waveforms, I could declare [...] a sample, for example, clarinet, saxophone, noises [..] and then play the sample with the notelist. Today I am still using programs that are not MIDI, I use MIDI too as a controlling device, I use also the old 'notefile' approach to control something that is completely software, a virtual instrument, that does not exist in material [world]" (44:*A160).

If in the examples above samples were used to incorporate the outside acoustic, often instrumental sounds, there pre-MIDI sounds converted into the form were also samples.[92]

III. Use of presets

"It's hard to say that there's really anything that was really new aside from starting to integrate different kinds of sounds. When you have a different instrument, it's going to sound different. [...] The other thing I found myself using some of the preset synthetic instruments as part of layers which I had never done before" (28:*B170).[93]

[92] See Chapter 4.8 "Transfer of Pre-MIDI Compositional Methodology into MIDI Environments."

[93] See Chapter 6.2 "Timbre and MIDI."

IV. Extended sound manipulation possibilities

"The kind of tools I was using before MIDI were scattered all over. Just about anything was fair game if it could be recorded. Putting it {sound source} on tape and manipulating it was what I was doing before MIDI. With MIDI [...], you had the addition of predoing it (honing, shaping, carving the sound before you put it on the tape)" (37:*B505).

V. Access to new sonic identities

"Because electronics have become much more subtle, much more delicate, you can more easily change from one instrument to another, from one family of instruments to another, from a drum-like sound to a voice sound. This kind of shifting quality I love, playing with identities, things are not what they seem to be, it's opened up a whole world. The microscopic examination of music available by computer, masses of sound, looking up the sound, detail of its structure, it's opened up a universe, just like a microscope when it was invented. You see things you didn't know existed" (35:*B50).

6.1.5 Rhythm

I. Finer control over rhythmic structures

"I realized that the musical meaning, the thing that I am after, can be so subtle: one-ninety sixth of a note, whatever the clock is, can totally throw off whether I want to keep this or not keep this. [...] Just slightly perturbing the timings of the rhythms in my synthetic drumming by even this very small MIDI grain in terms of time, I heard the difference. It really changed from the thing I was after to something very washed out. It was a very small change, much smaller than the time people measure to be a noticeable rhythmic difference. I was surprised at that point how much difference it made" (13:*C406).

"[Did you notice the difference in music with MIDI?] -Yes, sure. You could make real-time rhythms. The thing about MIDI for me which was interesting among other things [is that] my music is based on the activity and gesture of rhythm, it's not based on slowly changing timbral complexes" (15:*A315).

"I've done a piece using MIDI that is based on geometric ratios for all the durations and all the time units in the piece. What it comes down to is continually varied tempo on every event, but the tempos are in certain proportions. Every event has its own tempo in succession. MIDI was flexible enough in its rhythmic precision and representation to enable me to do that using MIDI" (34:*A215).

"It has become more involved in the abstracted, structural aspects of music because that's what you're composing with the software. In the analog domain you're more interested in actual, more tangible aspects of electronic circuits, rhythm, formal development. Recently, in the last couple -- three years I've gotten more interested in doing things with rhythm. That is something that I could definitely do with MIDI systems and no way I could do with the analog systems" (40:*B5).

II. Length of sounds in MIDI environment

> "It's OK now but for a very long time, it was even more difficult to make long sounds, extended, gradually evolving sounds that didn't sound mechanical. That's always a challenge in this medium, always. I found ways of doing that in the analog studio that worked very well. For a very long time it was very difficult to do that with MIDI instruments" (28:*B188).

The following statement contradicts the case for making longer notes. The MIDI instrument is also responsible for slowing down the tempo of the composer's music.

> "My music slowed down. Yes, slowed down because what that instrument gave us, I mean this is not so much MIDI as it is the DX7 which was the first MIDI instrument to be attractive to me, it was the FM, just the incredible timbral control you had with that synthesis algorithm. My notes became very long, so you could hear the timbres, long and slow music" (29:*A455).

6.1.6 Form

I. More flexibility to experiment with form with MIDI

> "The possibility of simulation of taking distance [away from the piece] has helped with using more flexible forms in the sense that I was able to try to experiment with musical form more than in the past, I could take more risks and be more adventurous in the use, for instance, rapid changes, more liberal [.. not clear] form. From this piece I mentioned, piece with TX816 and later I have used more flexible forms" (9:*A587).

> "MIDI played a role in a musical part of it {form}. MIDI made possible what you could do with writing in a text editor: you can be very free and just [be] shuffling around the idea. If you don't like it, you can revert to an earlier idea or can come to a newer form. It makes me free in relocating my ideas" (23:*B470).

II. Stricter forms with MIDI

The following excerpts show exactly the opposite of the statement above: how the structure of pieces becomes more constrained due to the use of MIDI.

> "Before MIDI the structure [of the pieces was] like in Indian music, changing very slightly using analog systems. After [the introduction to] MIDI I couldn't change the sound like this. Today when I'm composing my music I think about very strict forms" (10*A450).

> "In a weird way, even though the MIDI stuff that I do is more interactive which suggests it's going to be freer, in terms of form, perhaps, it's more constrained. What I do instead of shifting the piece as I am composing when I am doing a tape piece, I have a preset notion of where the piece is going to go. [..] In terms of overall form, MIDI stuff is more constrained just because I know I want to do this interaction for a while, I want to do this

[other] interaction for a while. Since I haven't realized these interactions, I don't have that opportunity to hear something here and say "Oh, maybe I should go here instead, take off in a different direction". If it happens in the context of performance, the way I've designed my pieces you really don't have an option, you really have to go on to the next formal section. Of course, with the tape piece, since I'm constructing it on the fly, I can completely redesign what I'm going to do next" (1:*A485).

III. Dependence of form on the use of presets

"Yes, well, I think there is a tenuous connection. The form of the piece has a lot to do with trying to overcome the inane quality of the timbres I was using. I tried to constantly vary the timbres because they got so boring, I'd get tired of this preset, that preset" (24:*A375).

IV. Ability to test forms

"MIDI allows to test ideas and to test forms. With the MIDI's ability to test forms, to test structures, even if it's only a test, a sketch, obviously, there is a feedback. I would not take the music as it is, it's another portion of time and form. [Does that change the final form somewhat?] -Yes, certainly" (4:*B370). "MIDI played a role in a musical part of it {form}. MIDI made possible what you could do with writing in a text editor: you can be very free and just [be] shuffling around the idea. If you don't like it, you can revert to an earlier idea or can come to a newer form. It makes me free in relocating my ideas" (23:*B470).

Extended possibilities for working with material in improvisational composition influence the formal result in the following testimony.

"If I have a good way of taking the good ones or the interesting finds and putting them in my bag, I can start to study what things they can suggest about music, about the formal result of the piece, how they combine with each other. It's very very crucial to do that, to be able to go back to the thing you've found. This is a really important point of working with MIDI, I discovered later. If I improvise in a certain way with these big knobs {pre-MIDI} exploring the space of some algorithm, it's quite possible I get a good one and then I want to hear that again – I can't find [it]. [...] It {the control system} has to be repeatable. You have to be able to go back to it and then make variations of that" (13:*A350).

V. Lack of connection between form and use of MIDI

In many cases the use of MIDI environment has no impact on the form of the piece.

"[Is there any connection between the use of MIDI tools and the form of "XXX" {the only MIDI piece}?] -No. I can't really say there is. The use of MIDI was intra-structural and also mediated by the non-real-time process of the filter application" (8:*add2).

VI. Choice of more interactive forms

> "[Do you find any connection between the use of MIDI tools and the form of your pieces those tools were used in?] -Yes. I used 'XXX' {compositional software package}, which was based on many of my algorithms and which definitely inclined me towards interactive processes (as against fixed structures)" (30:*add2).

VII. Longer pieces with MIDI

"[With all-digital setup] pieces became longer" (22:*B170).

6.1.7 Lack of Change

For the following reasons the impact of the tools was resisted:

I. Irrelevance of tools to the style

> "I don't think MIDI inspires me that's like saying 'Does ASCII inspire you?'" (32:*A180).
> "[Do you perceive any stylistic changes in music of that piece as influenced by your use of MIDI equipment?] -Well, hell: I knew what I was to use even though I had never used it before...no stylistic change per se" (19:*add5).

II. Consistency of style

> "I had evolved stylistically as a composer to the point when I was consistent before MIDI came along. I don't think MIDI has created any change in me stylistically as a performer or a composer" (29:*C390).

In the following excerpt, the timbral palette of the composer remains unchanged.

> "If you go back and listen to the stuff from the early 70s and compare to [my] music today, the sounds are very similar. My timbral palette as a composer has remained very consistent independent of technology" (29:*B185).

III. Impact attributed to factors other than MIDI

> "[Do you perceive any stylistic changes in the music of your MIDI piece, as influenced by MIDI?] -The stylistic changes were more due to the fact that "XXX" is a real-time interactive composition, rather than by the limitations of MIDI" (7:*add2).

IV. Insignificant role of MIDI devices in the setup

The role of MIDI devices is particularly insiginificant in the cases of the rare use of MIDI. For example, respondents 41 (and similarly 17) have replaced pre-MIDI controlling software used in live interactive performance with MIDI-based MAX without having to adjust their compositional style or ideas to this replacement. The following quote gives an appropriate example:

"MIDI didn't have a strong effect on me. Didn't change anything. It made certain things a little easier. The only reason I used MIDI and I still use it was just to [...] alter a few things which I could've done just with non-MIDI ISPW and MAX just moving sliders on the screen" (27:*A403).

6.2 Timbre and MIDI

	Yes	No
Developed computer-based timbres (software synthesis) before MIDI	29	15
Percentage 1	66	34
Developed computer-based timbres (software synthesis) after introduction to MIDI	33	11
Percentage 2	75	25
Used non-computer timbral sources (tape manipulation, sample, synthesizers) before MIDI	32	12
Percentage 3	72	28
Used MIDI presets	21	22
Percentage 4	49	51

Table 13. ***Timbres Before and After Introduction to MIDI***

6.2.1 Development of Computer-Based Timbres before and with MIDI

The evolution of computers, as Chapter 3.2 showed, occupied the central place in the development of electroacoustic music in 1970 and early 1980s. Sound synthesis using computer software was a wide-spread practice among electroacoustic composers, as attested by two-thirds of the respondents.[94] In those years, however, it coexisted and often overlapped with other techniques, such as tape manipulation, sample triggering, use of analog synthesizers and other electroacoustic instrument sources. The same table shows a comparable, even slightly larger number of composers (33 respondents, 75%) who used non-computer sound sources.

[94] Table 13.

Despite the boost MIDI gave to interactive composition using ready-made presets, use of software synthesis has been on the rise as well. It has grown modestly from 66%, two-thirds of the respondents in pre-MIDI years, to 75%, three-fourths, during MIDI years. In part, its growth can be attributed to the enhanced user-friendliness of the software.

> "I've been frustrated with limitations of the technology but I've never felt [the need] to spend the time developing it myself. A good example is my experience with the software synthesis. I studied MUSIC360 for a little while realized I was never going to get a piece done. It was just too cumbersome. I even went to Max Mathews's lab and did some MUSIC 5 and I abandoned it after a very short period of time because I knew I could get work done in the analog studio. I made a conscious decision that I am going to wait for other people to develop that technology. And now I'm working with C-Sound and whatever else" (28:*A440).

In only two cases (# 30, 34) has the use of MIDI synthesis phased out the software synthesis. "I was writing software to do software synthesis. I stopped doing that, I got enough MIDI tools together to do things there. I'm no longer writing software to synthesize the sound" (34:*B380).

The transfer of timbres from pre-MIDI to MIDI compatible software environments was sometimes a significant part of the overall transition to new technology.

> "A lot of the sounds I wound up programming on the NeXT to run in DSP were derived from sounds that I used in the Samson Box. I liked them, a lot of them were results of a lot of analysis and hard work. So, I just ported a lot of them over. And then, of course, they were MIDI-controllable because they were on the NeXT" (31:*A350).

6.2.2 MIDI-Controllable Timbres

6.2.2.1 Use of MIDI Presets

The ready-made timbres available in MIDI instruments, usually referred to as *MIDI presets*, opened a universe of new sounds and compositional solutions. For the first time, libraries of malleable, MIDI-controllable timbres became a major timbral source for composition. The very concept of offering a bank of believable sounds imitating acoustic instruments as well as some entirely original patches, was new. It caught on quickly with popular music, but did not fare as well in art music. Only about half of the interviewed composers ever used MIDI presets in composition.[95] Three out of every four composers used software synthesis,[96] but only two out of four would use MIDI timbres.

Pre-MIDI electroacoustic music was generally non-real-time, produced algorithmically in the computer environment.[97] Sound quality, here referred to as timbre, had been one focal point of the composer's interests in using electroacoustic means. It is hardly surprising that the timbral

[95] Table 14.

[96] Which itself underwent development and conversion to PCs in the first half and mid-1980s.

[97] See Chapter 6.3 "Live Interactive Electroacoustic Music and MIDI Tools."

qualities of MIDI instruments when they appeared on the technological scene were scrutinized rigorously by the composers.

	Yes/ Positive	No/ Negative	Undefined/ Mixed
Used MIDI presets	21	22	x
Percentage 1	49	51	x
Attitude towards MIDI presets (all)	14	27	4
Percentage 2 (all)	31	60	9
Attitude towards MIDI presets (MIDI users only)	11	8	2
Percentage 3 (MIDI users)	52	38	10
Satisfied with the quality of simulation of acoustic instruments	1	32	4
Percentage 4	3	86	11

Table 14. ***MIDI Presets***

Only 31% of composers whose answers are available hold positive opinions about MIDI presets. The negative opinions were shared by twice as many respondents.[98] However, among the actual MIDI users, presets were rated much better with 52% viewing them positively vs. 38% negatively.

6.2.2.2 Synthesis Implementation

MIDI instruments failed to provide the complexity of synthesis available in software synthesis. Limited by a number of resrtictions stemming from real-time and cost constraints, such devices could produce only as complex a sound as the facility would allow. However in software synthesis, there is virtually no such limit except for the compilation time which expands proportionally to the complexity of the task.

> "In modern instruments I don't really have sophisticated envelopes, in fact, you'd usually have 2-3 segment attack section and 2-3 segment decay section and that's about it. What if I want to make a 16-section envelope? Some of them can do it, some of them can not. It changes from synthesizer to synthesizer, some of them are easy to use, some of them are hard to use. But it's all compromises. If I'm doing tape music, why use that if I have in a software environment something that I can shape the way I want" (33:*B190).

[98] Table 14.

In particular, synthesis facilities in the original MIDI synthesizers[99] were minimal compared to the kind of FM synthesis available with software.

> "[Did the DX generation reproduce FM mechanism in a satisfactory way?] -Yes. I think they did a very good job. [But] there is a sub-universe which they haven't explored, (about which I was disappointed), that was the multiple-carrier potential. I asked them to implement the tables for the carrier-oscillator frequency so you could make it independent of the key, which they never did. [...] Had they done that, FM could have been a lot more intuitive to people like me [... who] were used to thinking about synthesis more like filters and things like that" (42:*A570).

Compared to software environments MIDI synthesizers were limited by usually having only one synthesis technique available.[100]

The scope of control over the development of sound was compromised even more. MIDI is deficient in allowing the user to zoom in on details of synthesis beyond a certain level.

> "If you want to work on some very specific calculation and very discrete and very continuous sound, for example like FFT or synthetic sounds or additive synthesis, MIDI is too simple. You can't have access to very important parameters for synthesis. For example, if you want to change harmonics over tone, you can't do that in MIDI. The definition of the sounds in MIDI is very global, very general, but in computer music we need to go into deep detail... I like very much to have interactivity, but when I wrote "XXX", there is a section with FFT, for example, to have an envelope which follows exactly the movement of the dynamics of the piano. After you give this information very quickly to the synthesizer to make the filtering of all the sinewaves, it is always impossible in MIDI to do that kind of synthesis because MIDI is too simple" (3:*A350).

By default, MIDI can not transfer information about timbre, since it operates on a higher level of control managing the parameters which describe the whole musical event but not its constituent elements. "The standard imposes limitations of several kinds. First, because MIDI communicates on the control level -- performance gestural events rather than any representation of the audio signal -- the standard can not be used to describe or control much of the timbral aspect of a musical performance. Control over synthesis and the evolution over time of any particular sound is coded into each synthesizer and may be affected through MIDI only by using an ad hoc collection of triggers, continuous controls, and system exclusive commands, private to each machine and inimical to the very idea of a standard" (Rowe, 11).

Despite relentless change of appearances, modifications and research, methods of sound generation available in MIDI instruments remained virtually unchanged with MIDI instruments. Frequency modulation and sampling occupy a central place up to this day. However the quality of the presets improved over the years of MIDI's existence.

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[99] E.g. only six oscillators in Yamaha DX7.

[100] See Section I of Chapter 5.2.2.

"There have been some stumbling blocks there. You can pretty quickly hear a sound or a patch, take it apart by ear and know what the ingredients are, that's something I don't think we've had any real surprises about, [we're talking about] the actual sound generation algorithms. There haven't been any new approaches put into synthesizers in 5 years. The first period of this dozen years involved a lot of refining FM [...], [in] the second half there was less of that. The point we're at right now, is sort of poised for this new sound generation techniques finding their way into commercial gear which would be additive synthesis, resynthesis, physical modeling, things like that" (13:*C235).[101]

6.2.2.3 New Concept of the Synthesizer

The new MIDI-based generation of electroacoustic equipment featured a new type of instrument -- a controllable module with ready-made synthesized sounds. That signified a major turn in the concept of synthesizer: from a unit responsible exclusively for synthesis of sounds[102] to a bank of sounds with limited synthetic facilities. As one of the composers said: "the world had gone from the instruments where you really play the sounds to instruments where it's basically about libraries of sounds" (43:*A360). This new idea for the instrument was not embraced by everyone:

"They [MIDI presets] suck. They originally thought that synthesizers were going to sound like a violin or be made to sound like a violin. I thought that was the most ridiculous research with that wonderful box one could think of" (39:*A420).

This conceptually new instrument had a commercial purpose, supporting its viability -- a quality stand-in representation for acoustic instruments. The *'new synthesizer'* apparently satisfied the needs of popular music. Some of the problems with timbres come as a tradeoff to the cost of producing a mass-market synthesizer.

"Many of them are very good. It can be that algorithms for making sounds are not easily controllable by average musicians who buy MIDI equipment. One has to remember that MIDI is a commercial standard and the MIDI world is hundreds of thousands worldwide. It's a small market at hundreds of thousands but still most of the users don't know very much acoustics, don't know how to make sounds and don't change the sounds. And they are usually looking more for emulative sounds than for new sounds. By far most users of MIDI want to come home and play violin, and trumpet, and a piano, and so on, at the keyboard on their synthesizer. They are not looking for new sounds" (30:*A235).

6.2.2.4 Ready-Made Sound Libraries

The availability of libraries of sounds is acknowledged but not necessarily welcomed by art music composers. Such voice-bank synthesizers had come into existence in the beginning of the 1980s.[103] However, the idea of the ready-made sound itself contradicted the do-it-yourself

[101] Also see Chapter 3.4.2 "MIDI Equipment in the Mid-Late 1980s."

[102] With the exception of sampling synthesizers.

[103] For example, Synergy introduced by Music Technology in 1982, had 24 pre-programmed timbres and a

approach of software synthesis which emphasized unlimited possibilities for experimentation, and enjoyed little popularity before or with MIDI.

> "You have this completely defined world which has been decided by the commercial music manufacturer for you, like someone gives me a box of paints and doesn't allow me to make my own color. [...] I'd be the guy to go out, dig around in the woods for my colors if I were a painter rather than going to the store to buy tubes of paint, maybe that's the best analogy" (27:*A304).

Easiness of instrumentation with veritable acoustic instrument replications, the concept beneficial to popular music, was not that appealing to some art composers.

> "This music [produced with Yamaha-SY99] was easy to produce if you accept certain things, if you accept to use the presets. Of course, you can have very pleasant sounds and fields of sounds very easily. There are many very complex sounds these days that evolve in time in interesting ways. All you need to do is find some nice harmonies and nice rhythms. Of course, the whole instrumentation becomes extremely easy, but easiness is not something that specifically interests me. This experience showed me one way of producing a certain kind of music" (20:*B116).

Several composers point out a lack of interest in the tradeoff of quality vs. compact allocation of simulated sounds in art music, popular and art music.

> "I don't think the attention to simulation was quite as strong in the laboratory environment as it was in the commercial world. People weren't interested in creating the band in the box whereas for commercial purposes it was an important feature. And yet, in the lab environment you're always trying to get a better violin and that's another part of what we do" (13:*C209).

> "I'm not interested in recreating the musical instrument per se. [...] If I use recorded music, it's the music that I'm interested to somehow explore. For me people who try to recreate a five-piece combo in their living room are on the wrong track" (25:*A400).

Joining the discussion, another interviewee defends the appropriateness of using presets when they are applicable and avoids outright rejection.

> "That whole process made you rethink the nature of how you're using sound, how all the parameters and aspects of musical experience are being created. What MIDI does today is often give you a whole bunch of ready-made things. This is an essential argument against using presets, that it's something more of prescriptive force, "thou shalt not use presets". That is just as unthinking as the opposite. I think if you're going to use presets you should really think of what those presets are doing. They may be the right thing at the right time and they may be the right thing to use. It's rarely so black-and-white as people present it" (34:*B320).

From another point of view, the preset idea can bear a lot of **positive** value. Using the ready-made model, points out another composer, as the starting point saves a lot of effort and socially is more accessible. Once their imperfection is accepted, the sounds can then be used as a template to build on new, more interesting sounds.

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cartridge slot for cartridges with additional sounds. The sounds could be modified by front-panel controls, but the user was not provided with facilities to produce original sounds.

"On the factory preset thing you have a lot of instruments and models proposed that you can then fiddle with and make a trumpet more like a trumpet, a drum more like a drum, and strings more like strings in any way you want, or less like strings if you want. They helped the composer who didn't go particularly deeply into FM programming with a kind of leg up where you start, put it in your piece with orchestral trumpets and have them play together and make the FM trumpet do something which transforms orchestral trumpets and there's your starting point. It made me feel at home whereas other synthesizers had no ready-made models at all" (35:*A440).

One of composers gave a peculiar example of using exactly the orchestra-in-the-box idea for realization an orchestral piece. The result receives a mixed opinion.

"What happened when MIDI instruments arrived, my first experience with them was simply synthesizing an orchestra piece that I did. I did that one when the DX7 came out. I needed to be able to perform the piece without the orchestra, because I put a lot of effort into it and used some of my electroacoustic instruments. Anyway, I synthesized the orchestra using the MIDI instruments. It had some good things. The trumpets were terrible, that part I always hated about it. [...] They {presets} were adequate but I never really honestly liked them. [They are] adequate in representing the sounds structurally and in the frequency of the sounds I conceived of as acoustic instruments. They made an adequate representation of that aspect of the piece, but to me it was always a pale limitation of an acoustic orchestra. It gives a flavor but doesn't really substitute. [...] I enjoyed working with the FM implementation that's in those instruments, I found a rich source of timbres but I prefer thinking of them as electronic sounds rather than simulations of acoustic sounds which they are" (40:*A150, *A275).

Easy access to the libraries of ready-to-use sounds paradoxically created a new constraint -- the limited number of those timbres leading to a **lack of freshness or novelty in sounds**. For composers who were used to the extreme range of available timbres that electroacoustic music provides, this constraint ruled out the use of MIDI tools.

"I couldn't stand most of those sounds! Maybe because a part of it is cultural -- the libraries became such a standardized way that people worked. You started to hear them all the time, over and over and over again, and you got sick of those sounds. Once again, yes, there is system exclusive control, and the pitch wheels and breath control and all that sort of stuff, but it's very primitive still in terms of controlling a waveshape as if it was a piece of clay that you could mold when you play. Because that was so hard with MIDI, you started to hear these things that had a particular nuance programmed into the sound that didn't vary, you just heard over again from one composer to the next, over and over" (43:*A360).

"The only reason I don't do that {using presets} is because so many other people have. If in a particular piece timbres are really important, and I want people to focus on that then I'm not going to want to be doing something that's what people have heard somehow. It's just part of the fun or the game or the interest work for me has to do with developing timbres" (6:*B537).

The following example proves the same concept from the opposite side by employing presets when timbres are not important.

"Generally speaking, the vast majority of presets are of no interest to me. First of all, the good ones are overused by musicians. There are all sorts of clichés that abound in music today down to the fact that you can identify such-and-such preset from such-and-such a machine. To me, the fun of making music is, for the most part, creating new objects, either take something that exists and change it or start with something from scratch. This is not always true. Some pieces that I've done have been about things other than timbre, or the timbre is basically irrelevant to the extent that I might want to use timbre simply to distinguish one voice from another. So I might even use standard presets" (25:*A365).

A number of interviewed composers did not use MIDI synthesizers because they were not interested in using a MIDI patch instead of an acoustic instrument. Those imitations were prevalent among the timbres available in the MIDI libraries. "If I want to use the original sounds, I would use the original instruments, not the bad copies. If I want to write for a piano, I'll get a piano, there's nothing better than a piano as a piano and never will be" (33:*B150).

Our next respondent agrees with the previous opinion but also points out interest in using the computer for synthesizing original 'unacoustic' sounds.

"I was not impressed [with MIDI]. Technically it's great but the musical components were not designed in any way that I thought would be useful to me as a composer: timbres, presets. [...] If I want a piano sound, I want a real piano. [..] If I really want a flute sound, I will get a flute. I don't want to use a computer to simulate an acoustic instrument. I think [in] a computer for me, the attraction that goes for all electronics, is that you create your own timbres, you're working with sound, anything your imagination can come up with; that you can try to the greatest degree possible to produce that with the computer.. Why use it for a flute when you can just get a flute sound?" (16:*25, 60).[104]

A sharp division between the two groups of available presets, *imitations* and *effects* was observed by another artist.

"I was simply not interested in the sounds [of early MIDI synthesizers]. First of all, they were imitating the presets, it was a preset box, basically, where you could change things, but [like] all synthesis these days you had either presets imitating 'real' acoustic instruments, or you have effect sounds, and that's all you have. There is nothing in between, there was no way of really getting into the sound itself, and changing it and making it more interesting, adding things which would maybe stimulate to work them, because I don't want a xylophone or a French horn" (19:*A445).

With another composer, an opportunity to have both effects and imitations in the same box was particularly beneficial.

"After many years I came back to purely acoustic music. It [the use of SY77 in a predominantly acoustic orchestra] was like a security exit that if I were to need something and I wouldn't be able to write with 104 other instruments. [I used it for] exact microtonal structures. I imagined one place with some bells with glissandi and noise imitating sea noise, just noise - [I used it for] things which were easier to be able to sound than try to, for example, explain in great detail to a percussionist. Maybe all of that could've been [done with acoustic instruments] - you can make glissandi on bells when you put them through water and things like this but I always went writing for big

[104] We will discuss the quality of simulation in Chapter 6.2.3 "Simulated MIDI Preset Timbres."

orchestra, I wanted to be quite practical because it's a mess anyway, there was so little rehearsal time. It's there, it's audible, it maybe gives its special flavor to the piece" (20:*A400).

6.2.2.5 Timbral Quality of Digital Sounds

Digital synthesizers had a specific ***sound quality*** to them. However, there is no consolidated opinion on beauty and freshness of those sounds. These opinions vary as dictated by taste. For some, these sounds were not breaking news. Frequency modulation synthesis has been available for years before Yamaha DX7.

> "Early MIDI synthesizers sounded like s***. They were either cheap samplers or FM boxes. By the time they came out, FM was already a cliché - we've been doing tape music for ten years, so, for a lot of people DX7 wasn't a thrill" (7:*A333).

It is quite interesting that even though MIDI synthesizers did not bring about any *original* timbres that remained as distinct and new, as some other electroacoustic instruments like Theremin, or Moog, some of the MIDI clones of acoustic sounds, easily recognizable due to their specific sound quality,[105] became vernacular in electroacoustic music and as such distinctive timbres. This ambiguity of originality vs. simulation is evident in the following quote:

> "I enjoyed working with the FM implementation that's in those {MIDI} instruments. I found a rich source of timbres but I prefer thinking of them as electronic sounds rather than simulations of acoustic sounds which they are" (40:*A275).

When used excessively what stands out as distinct can easily become a timbral cliché.

> "It's hard to get past the cliché aspect of it, the fact you're doing the same sound everywhere in the world, and every studio can produce these kinds of things. [...] As soon as I hear that it's an old idea, it's imitating instrumental world, smacks of mass culture and the whole listening attitude -- everything about it is wrong" (26:*A115).

Grotesquely, familiarity and lack of imitation quality would be used by composers for exactly that "I could sometimes use them {presets} as a banal expression of stupidity. I've never believed in that approach but I've used it" (23:*B140).

6.2.2.6 Cited Shortcomings of Presets

The *'new synthesizer'* did not meet the specific compositional needs of some composers. Often negative responses would highlight a problem in the instrument design.[106] In the sound quality domain, the following problems have been reported by the respondents:

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[105] For example, the "MIDI Piano" sound, "MIDI Synth" bass, that famous "Orchestra" patch...

[106] See Chapter 5.2.2 "The Negative Sides of Design of MIDI Instruments."

I. Vibrato

"It {Yamaha DX7} was picked up by everybody but I didn't think it was any good. Part of it was the lack of the control of vibrato, they were basically boring sounds. If I remember it right, there at the time, the timbres I was playing with depended heavily on complicated games with the vibrato, that you couldn't do on those synthesizers. You probably could do them now, I don't know" (12:*A348).

II. Sensitivity

"The sounds that they offered and their control seemed to me poor and unrefined. In the sense of sensitivity. I was going to acoustic instrumental world and instruments that really interested me, and still interest me, like string instruments, you have very sensitive control over the sound all the time with different parameters with two hands. Somehow these MIDI instruments seemed to me very elementary" (20:*A315).

III. Warmth

"[Were MIDI preset imitations successful?] - Pretty much. Except for the digital sound is not as good as the PCM-42 sound. Not as warm. [Warmth is] full spectrum of sound. If you leave something out, you're leaving something out and it subtracts from the quality. I don't know where it cuts out but I think that there is a lot of stuff in the sound that keeps on going past 20 Hz. You can feel it, you're detecting it in some way if you can detect any difference between a live and a digital sound" (41:*A445).

"It {DX7} was something different, it would still have a certain warmth to it that I think some of the earlier synthesizers had, warmth of sound, ... colorwise. It began to have a little more edginess than some of the earlier synthesizers: Moog, Buchla and the like. [...] Aesthetically I found that some of my digital instruments today have a little coldness to it that I feel, that I always have to find ways of warming them up a little. [Are you talking about preset sounds?] -Yeah, and things that I make. In other words the electronics seem to get between me and the sound" (37:*A475).

IV. Reverberation excess

"I think there is an overriding thing with the electronic music. Not just with the electronic music, but essentially the electronic music mind identifies it as a particular way of creating sound -- they are in love with the reverb and the echo. [..] I use it but also I have a very strong antipathy towards it and [what] that has to do with [is] it puts a skin on the sound, like an onion, it rounds out everything into a sameness" (37:*A580).

V. Complexity

The lack of complexity connected with the predictability of results is cited in several negative opinions. MIDI presets, mathematically laid out, are "too perfect" (16). They would be unlikely to carry along the randomness, unpredictability present in natural acoustic sounds.

"[What is it that you can't find in MIDI?] -A certain amount of complexity in the sound itself. When you touch an instrument and it has a direct physical response like an acoustic, if it's a good piano, you get the sound quality and degree of expressiveness that I don't think you can ever achieve with MIDI keyboard instrument. You play one note and you can say 'Wow! that really sounds like a piano!' I can't tell the difference. As soon as you play a bunch of notes in a row, to my ear they've all got the same envelope, every key has exact the same envelope, it doesn't vary. There's something flat about the sound. MIDI sounds flat to me in terms of traditional acoustic instruments. [...] It [MIDI timbre] is flat. It's not dynamic, it doesn't have this life energy quality. When you hear a live instrument, things are bouncing around and you play this G this time, it will never sound the same as when we play again. MIDI guarantees you that kind of precision. It's too precise. [...] It's too perfect" (16:*B150).

"They are absolutely awful. They are OK for testing. Sound quality is awful - I hear there is not enough randomness, there is not enough richness in the sound, there is not enough shaping of time dimension of things, time envelopes. The sound is stiff and still. The sound quality is too instrumental" (17:*B166).

Crudeness of control over sounds is seen as a result of the crudeness of the MIDI protocol, as described in this excerpt:

"I think most of them are terrible. MIDI, in general, is a terrible spec for sounds. One realizes the more and more delicate your controllers are, but the handles you have on channeling MIDI sound are terrible because MIDI itself is such a crude specification. It's almost impossible to make a good sound with a MIDI synthesizer" (30:*A255).

Another respondent attributes lack of complexity to several problems in synthesis design: uncontrollable attack, looping and undeveloped pitch/sound relations.

"Very obviously it was wrong with the timbres. With FM and such you could not control the attack, you are not quite sure what you get -- that's one thing that's wrong. If I want to imitate 'real' instruments, I certainly have to get the attack sound right [...]. Then, the looping, if you can hear the looping of the sound, that's bad. The fluctuation within the sound is uncorrelated to the development of the pitch. You can just read any psychoacoustic book on the complexity of tone, it {the complexity of tone} is not there" (19:*A460).

6.2.2.7 Positive Response to the Quality of Preset Sounds

A number of respondents were very impressed with the quality of new sounds.

"I can't separate my initial [positive] impression of MIDI from my initial impressions of DX7 and voicing that came along with that. We had obviously some very impressive moments when there was this portable keyboard creating simulations of acoustic instruments that'd been so nicely voiced, that it was quite a rival to anything coming out of the big mainframe computers around the same time. As a by-product it happened to have that MIDI jack. I didn't understand much about it at that point but I was thoroughly intrigued by the synthesizer" (13:*A15).

"I found something about the clean quality of many of these sounds produced by FM and the fact that you could make them rather easily evolve in time by changing modulator envelopes and so on -- exciting in itself; but also, and perhaps, more important, that it blended well with other instruments" (35:*A440).

Respondents who approved of the sounds of the new synthesizers capitalize on their control features, provided it was particularly important to their work. The continuation of the excerpt above addresses the possibilities for interactive control and editing of sounds impossible before.

"The first time it became an obvious asset [...] was actually when I saw the possibilities of controlling the DX7 from the computer for voicing. Again, that was the thing that was astonishing in quality of the voices. I had 5-6 years experience with FM, it was great stuff. David Zicarelli created the voice editing system on Macintosh which goes through MIDI by MIDI connection with DX7, gave you a command module to get inside the patches, change them. Of course, that was very significant and impossible without MIDI, so that adds another name to the batch - Macintosh [...] You couldn't imagine taking over one of the mainframes and doing any sort of interactive editing or composition of the kind that you could simply have with a Macintosh and some sort of sound output with MIDI" (13:*A30).

This response should be compared to the one from a composer who was initially interested in interactive realtime control, but whose aesthetic disapproval of their sounds led the composer to avoid using MIDI instruments.

"The most limiting thing for me as a composer really dealt with the mechanisms of the time that were interfacing to the MIDI devices themselves. If you wanted to have realtime control, you had to rely on the sounds that were coming out of these synthesizers that were just ugly sounds, I'm sorry. For those of us who have been synthesizing sounds for years and getting these glorious sounds because we could put random number generators, we had floating point calculations, we could do all these incredible things -- when we heard MIDI orchestra instruments, we were horrified! The acoustic simulation was not sufficient, not the fact those devices weren't very elegant for what they did, [...] the beginning, the DX7, that's a very complex machine when it was first invented and FM algorithm was patented. Those were very complex algorithms on that machine" (14:*A290).

In many cases, the "if you can't beat them, join them" approach helped to move from initial disappointment with the ready-made presets through complex transformations using control tools to satisfaction with the result.

"Most of them were terrible, you couldn't use them. What you have to figure out is a kind of a way, other kinds of things to change the sounds in parallel in very subtle ways. The sound of an acoustic instrument is very subtle: you hear a trombone, it doesn't turn into a cat, but somehow you don't get tired of it the same way you'd get tired of the sample of the trombone or an FM trombone. There'd been various synthesis strategies which had been designed to minimize this effect of habituation. So, from my standpoint, what I found is using the controller functions in MIDI, I could change very subtle aspects of the synthesizer, that I can get control of: reverb-time, or changing the pitch, or something like that to make very small transformations in the sound while it was happening. You start with the presets and you try to make them as malleable as you can" (15:*A420).

Better control is seen as a way to de-cliché the presets.

> "There are a lot of perfectly usable sounds that are ready-made nowadays. These sounds are often too uniform, but even that is starting to change with things like the VL-1 where the preset sounds have a lot of controls" (32:*A550).

The idea of evolution of control is best narrated for in this excerpt:

> "There is this joke 'Note control is necessary, in fact, note control is possible'. MIDI is or was like that for a long time, [...] it's harder to have refined control over the notes in MIDI than that it is using something like MUSIC 5 or software synthesis. It doesn't mean it's impossible. Especially in the beginning it was harder, it's becoming easier and easier, people are also becoming more sophisticated. MIDI synthesizers didn't allow as much control over the sound, over the data stream. You can set the voice and those become qualities of the voice which are not adjustable remotely. There are MIDI controllers and such, but early synthesizers did not allow all that much to be controlled by MIDI controllers. You compare the amount of parameters that [Yamaha] TG77 {which was released later} allows you control remotely to those of DX7, there is no comparison. As MIDI synthesizers have involved, every generation allows you to control more" (32:*A290).

Four respondents (including two who used MIDI)[107] did not fall in either 'positive' or 'negative' response sections, constituting the 'undefined' group. "I don't think there's anything about them per se that is one way or the other" (21:*B60).

6.2.3 Simulated Timbres in MIDI Presets

"*Are you satisfied with the quality of simulation of acoustic instruments in MIDI preset timbres?*" Depending on the composer, we encounter a wide range of responses.[108]

The absolute majority of the presets in MIDI instruments simulate acoustic instruments. A quick survey of several MIDI synthesizers[109] showed that the less musical background assumed of the user, the higher the number of acoustic simulations. More sophistication demands higher cost of the instruments but also brings about more unusual, innovative sounds.[110]

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[107] Table 14.

[108] Some of the epithets used by the composers to describe MIDI preset timbres: 24: *plastic, kind of artificial, 'candy music', stupid, banality;* 30: *terrible;* 32: *bland overly boring surface texture;* 40: *adequate;* 37: *damn good.*

[109] Table 15.

[110] Some sounds are hard to classify between the two groups which leaves a small error margin. For example, non-musical sounds ('Telephone', 'Hammer' etc.); electrical sounds ('MiniLead', 'Syn Bass', others) and interpolated sounds ('Chorus Piano' etc.) were assigned to the effects group. Others including well-known electroacoustic sounds (like electric guitar or electric organ); acoustic group sounds ('Orchestra', 'Brass Ensemble') were assigned to the acoustic group.

	Yamaha PSR-520	Yamaha SY-77	Yamaha VL-1
All timbres	128	128	128
Timbres not simulating acoustic instruments	32	42	52
Percentage of simulating timbres	25	33	41

Table 15. ***Yamaha Synthesizer Timbres***

While the overall number of voices remains the same in all three synthesizers, the number of non-acoustic simulation presets rises from 32 in Yamaha PSR-520 (low end of the market), to 42 in Yamaha SY-77 (priced mid-range), to 52 in Yamaha VL-1 (upper end of the market) but still not occupying equal place with the simulated sounds. The division is particularly clear in PSR-520 where the sounds are divided into 10 banks according to the predominant simulation type: Piano, Mallets, Organ, Guitar, Reed, Strings, Ensemble, Bass, Brass, Pipe, Synth Pads and Drum Kits.

Before the crossover of electroacoustic media into the mainstream took place, an electroacoustic device loaded with rich but non-traditional timbres would have had a harder time being accepted by general market than a box with simulating timbres. That was one of the reasons why pre-MIDI devices did not succeed in conquering the mainstream musician market. The novelty of technology had to be justified by the connection to the tradition. Englert expressed a similar opinion on the place of computers in music in 1985: "The presence of computers is not completely accepted on the musical scene. For a long time, it had to be justified by the imitation of tradition" (Guiseppe Englert in Symposium on Computer Music Composition). Nowadays, the search for unusual and exotic sounds is apparently commonplace in popular music, thus the voicebanks of such sounds (as well as samples of analog synthesized sounds, as vogue would have it) are available on the market.

The very necessity of simulation is disputed by several composers.

> "I always had these arguments, why do that? Why don't just play the instruments? Why bother going to all this exercise of matching it? Yet, I kind of come full around myself, because I have samplers where you come pretty damn close, although there are certain things that are never going to be there in sampling and certainly some music instrument manufacturers have gone a long ways to do just that" (37:*A514).

> "If I want to use the original sounds, I would use the original instruments, not the bad copies. If I want to write for a piano, I'll get a piano, there's nothing better than a piano as a piano and never will be. For me the beauty of these instruments is finding alternative sounds" (33:*B150).

The general opinion about the quality of simulation of acoustic instruments in MIDI presets is overwhelmingly negative -- 32 composers (86%) of 37 who answered the question.[111]

[111] Table 14.

"DX7 presets for simulation [of acoustic instruments] were non-linear, some of them were quite interesting. most of them were quite poor, plastic. They were just unable to capture something which was convincing about an instrument, and most of all they were unable to offer a stable vision of the instrument across the registers..." (4:*B300).

"The simulating ones I found most of the time very poor. When you listen to them, you hear the electronic part. You hear that it comes from the electronics. This is not what I am very fond of" (22:*A405).

"I don't like it {presets}. It's just so terribly bad. [...] Take the best imitation of a violin, put it through a loudspeaker and put a real violinist next to it, then you hear it, then there is something really stupid about that whole story. [...] I understand that engineers want references but this whole research phase got much too much influence on how composers started to use these sounds and I think that's really stupid. You can use them if you can use the banality of these sounds" (23:*B185).

The only composer who, according to his answer, is satisfied with the quality, at a closer look invalidates his own statement. "Yes, it was OK. I didn't want it to sound like a xylophone, I wanted a slight difference" (35:*A315). Acceptance appears a better way to describe his attitude than satisfaction.

"They {MIDI presets} were very satisfactory with a little bit of treatment, tinkering. [..] I just accepted what the synthesizers could do, there were only one in about eight instruments. They have simple vibraphone-like tones, xylophone like tones - the sounds which I used tended to be this type. Some of them [were] complex, inharmonic sounds which I programmed, but there were very simple, factory-type sounds which I just accepted" (35:*A290).

Several composers distinguish the degree of simulation success with different orchestra groups. *Percussive* and *plucked* sounds fare better than others.

"Since some MIDI sounds were not easy to control, basically, the sustained ones, because you had to control the way in which they are sustained, each voice, like an instrumentalist does (violins, winds are not polyphonic), so what worked better was percussive or plucked sounds. There was an immense number of even serious music embodied with this plucked sound and that's a very specific period and people sort of react against this" (38:*B460).

"[Did the MIDI preset violin sound like a violin?] - No. Best were percussive sounds, certainly, or the clarinet, but there the attack didn't quite work out, but the spectral controllers were OK. The French horns with lots of reverb might have worked OK too" (19:*A510).

"There are some nice sounds like harp" (20:*B200).

"When I think about the [MIDI] pieces I did, they are very percussive. To me, percussion stuff on MIDI sounds best. I didn't do a whole lot with FM sounds. Bear in mind, this is Yamaha FM gear we had to deal with. I've heard them on too many Ford commercials or something. And the strings sounds were just nasty. That would also lead me to do notelist event type of things, very quick sort of things, and not very long, evolving timbres. [..] Generally I'd tweak them {presets} to make them even more percussive. I guess the ones I found really satisfying were percussion-like timbres" (1:*A420).

Simulated *strings* and *trumpets* did not receive many compliments from the composers. "The presets, most of the time, things like strings are not very convincing. [...] No, they don't sound right. If I am given a choice, I'd choose using live instruments in the studio" (28:*B25). "The trumpets were terrible, that part I always hated about it" (40:*A150).

Another opinion, mixed in valence, distinguishes different level of success not according to different orchestra groups but to the *continuity* of the sounds.

> "In general, I would say, the sustained tones are very deficient. Primarily because there is more control over continuous random deviation whereas percussive tones, they have another way of evolving and that's not a critical issue. My use of these is almost entirely percussive I avoid like the plague sustained tones" (42:*A475).

Problems are seen in the context of *phrasing* when a single sound is represented well, but a sequence of sounds in a group is not convincing. "For single notes some samples and presets sound OK, but they never capture the behavior of acoustical instruments in the way they handle transitions" (45:*add2).

A similar problem comes up when simulating a variety of *playing techniques*.

> "As long as it goes to completely basic playing techniques, some of them {the simulating presets} are OK. But in my acoustic music, my playing techniques are very developed and specific. That's one reason I would never use them just to replace acoustic instruments" (20:*B200).

One of the problems impeding the quality of simulation is that it is impossible to control simultaneously several layers of sounds via a single MIDI control input.

> "[Presets simulating acoustic sounds were] both impressive and difficult to control. Some of the simulations were very good in some sense but could not be as good as the control. For example, if you play with a keyboard something which is a violin or a saxophone, simply there are things you can't do with the keyboard because you can not control the swell of the sound during the note, or you can do that with another controller which is not very easy to use like amplitude or wheel or pedal or breath [..] but it means you can not do it polyphonically. Here you come back to the kind of instrumental situation where the user has to be the instrumentalist, and has to be a good instrumentalist, otherwise it doesn't multiply the resources of the instrumentalist directly. Like if you use the breath controller to make swell but then you make calls, all the notes of the call go under the same control which is very easily stereotyped (like an accordion exactly). There were quite some feats about the simulation that were very good but also some deficiencies because of the control part" (38:*B210).

By using multiple controls for a single timbre, it is possible, according to one of the interviewees, to achieve a good simulating effect.

> "[Quality of simulation?] -Depends. With a good controller and a good performer, you could have some quite good violin tones. I've seen David Bristow do that but for one

voice; he has to use pitch control, pedals, and the violin is performing. It takes a lot of skill to do that, but he could do that" (42:*A490).

The lack of MIDI timbre complexity discussed earlier is directly related to the low quality of simulation. With less parameters to match, the sound moves further away from the original.

> "That's what MIDI is so bad at -- just play a note on the violin, there is a package of 20 different things that happen and they are all very complicated. Sure you can get them from a MIDI synthesizer sounding sort of like a violin but when you start to factor in musical context, there are so many things that go on: noise, and randomness, and tension, and stressing, and unpredictability that translating it from a synthesizer to a real person is a very difficult process" (24:*A508).

> "[Simulation is] generally very poor. There is no detail. If you have all similar attacks, you get very tired very soon. There's just not enough information to make a simulation that comes near to the 'dirtiness' of acoustic sound" (41*A320).

6.2.4. Role of Software Synthesis after Introduction of MIDI

- What were other options for work with timbres aside from using MIDI presets?

Software synthesis has continued to be the predominant source of sounds: 49% of composers used MIDI presets vs. 75% who used software synthesis after introduction to MIDI.[112]

> "I never used any MIDI sounds in my music at all. I don't like the sounds, at least, I haven't in the past liked a lot of the preset sounds. I've always been involved with high-speed digital signal processors as a composer, I never felt the real strong desire to explore a piece of MIDI gear on the system exclusive level myself. I guess I don't have any need to, I have other gear, more powerful, more sophisticated than MIDI gear. If I hadn't had access to the gear I had access to, I'm sure I would've spent a lot of time playing around with the MIDI gear, with the MIDI exclusive controls. The early stuff was basically just using Chowning's algorithm so that was pretty basic, pretty simple" (27:*A304).

In this example, the extinction of analog instruments meant that the composer, who would accept neither MIDI sounds, nor software synthesis, turned to samples. The result was plausible but not entirely satisfactory.

> "Even the wind controller couldn't get the envelope I was after. From the very beginning they were much better in the analog [domain]. And to some extent I had to compromise what I was doing slightly in terms of the extremities, so what I went to was the sampled sounds so I could get the sounds the I wanted, but it wasn't being generated, it was pre-created and only slightly modified, it wasn't like the sound that would evolve like it did in my pre-MIDI pieces. [..] That's still a ways off. The computer still can't follow fast enough, that's still not there yet" (21:*A297).

This disappointment is shared by another interviewee who followed the same route.

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[112] Table 13.

"Usually, at least in FM, I thought they {presets simulating acoustics instruments} were missing the point. They weren't very lively and if I wanted real instrumental kinds of timbres, samplers were becoming available so I used samplers. Even then samples seemed a little bit limited because of the sample architecture: you couldn't sample on the fly, you tended not to be able to do very complex things with the vibrato, glissandi and so forth" (18:*A370).

Another alternative technique cited in an interview is *layering*:

"I usually hate them. I think they've gotten better sometimes. I do use them sometimes but I always layer things, that's one of the ways I develop sounds. That comes out of the analog tradition, layering" (28:*A600).

6.3 Live Interactive Electroacoustic Music and MIDI Tools

The results of our survey show that 13 composers (29%) have never written live interactive music. Usually such preferences have been a result of a different focus of the personal compositional interest.

"I somehow didn't get into it {interactive composition}. Maybe [because of] myself, not being a performer at all, many friends who were more into it, more half-performing musicians, somehow, they more easily started to play with those ideas" (20:*A320).

	Yes	No
Composed live interactive performance pieces before MIDI	21	24
Percentage 1	47	53
Composed live interactive performance pieces after introduction to MIDI	30	15
Percentage 2	67	33
Availabillity of MIDI influenced the choice for writing live interactive music	18	22
Percentage 3 (of all who responded)	41	59
Same for those who wrote live music after introduction to MIDI	18	11
Percentage 4 (of those who wrote it)	60	37

Table 16. ***Live Interactive Electroacoustic Music***

"I couldn't accept the timbre limitations of what you can do in real-time. The synthesis is rather crude and the interest was rather in the interaction, which is more interesting to the composer than usually to the audience" (26:*A100).

21 (47%) of the interviewed composers reported writing live interactive pieces before MIDI.[113] Depending on the composer, those cases range from one piece to the regular compositional practice. However the facilities for interaction were severely constrained.

"In pre-MIDI times there was no interaction between the instruments and tape. In pre-MIDI times we had tapes and a lot of tape because hard disk storage was very expensive at that time so we had to immediately transfer it onto tape. The mixed pieces -- the pieces with instruments and computer-generated tape -- were done in this way. There was interaction in the hands of the performers but there was no technological interaction. On the other hand, to make the sound files, to make the tape part, the electroacoustic part, I don't see much difference before MIDI and after MIDI" (44:*A150).

"Interactive pieces I'd done before MIDI were with analog studios and some digital control. Those pieces were highly constrained by the lack of sophistication of instruments. I don't think those pieces are mature pieces because the instruments were so limited back then: Moog synthesizers, random digital sequencers" (32:*A525).

Naumann (1985, 397-399) divides performance situations for pre-MIDI electroacoustic music performance into three groups: tape pieces, "Live Synthesis" and "Recorded Tape and Live Performers", and "Tape Delay and Live Performers". He even sets aside a chapter proposing (Naumann, Ch. 16) sixteen composition projects "designed to develop the student's compositional skills in electroacoustic music." This list is a very interesting document in itself: it presents the most popular composition/performance models existing in pre-MIDI electroacoustic music.[114]

	Yes	No
Tape pieces before MIDI	42	2
Percentage 1	95	5
Tape pieces after introduction to MIDI	36	7
Percentage 2	84	16
Use of MIDI for tape pieces	21	19
Percentage 3	52	48

Table 17. ***Electroacoustic Tape Music***

[113] Table 16.

[114] See Appendix E.

In terms of performance situations the tape performance dominates the landscape before MIDI: 95% wrote tape[115] pieces.[116]

The following quotes point out some of the reasons why the majority of the surveyed population did not write live interactive pieces before MIDI:

> "[Before MIDI] it didn't interest me as a medium. What you could do was limited, you needed an awful lot of equipment to be able to do fairly sophisticated things. And hauling the [Buchla] 200 stuff around... it could be pretty heavy. It wasn't meant to be moved around, it was really heavy. It really wasn't a movable system at all" (06:*A72).

Another respondent answered our question whether the interactive piece recently realized with MIDI could have been realized before MIDI, noting:

> "Not in real-time because it was interactive algorithmic composition, [...] there was something smart happening, it wasn't just a trivial MAX patch, or all MIDI - it was real computer processing going on. I couldn't have done that on PDP 11 or some other machine previously" (07:*A225).

> "The question of interactivity, I [had] never really wanted to address it completely before MIDI was around. Partly because it was too complicated, and specific machines I knew were going to disappear, be replaced by different ones" (38:*C160).

> "I wanted to do a piece for an instrument and sounds from a synthesizer but I realized very quickly that synthesizer is very hard to get it available, especially on the stage. [For live performance?] -Yes, that was my idea at some point but I renounced it because I realized it would be too complicated and it would be played maybe once, maybe twice. [..] So I did the piece for tape partly using the sounds done real-time with the [synthesizer] system but fixed on tape - which is a limitation and a constraint" (38:*C70).

With the coming of MIDI the percentage of composers writing music for live interactive performance has grown to two-thirds.[117] E.g., respondent #13 answering my question "*What made you switch to MIDI?*" said

> "I guess these enhanced possibilities for a real-time approach. If I'd had equally fine opportunities to do real-time work with equally powerful set of voices and equal access, AppleShare of some kind, if I could command the computer to myself for extended periods of time to my experiments, I wonder if MIDI would've been as attractive" (13:*A300).

There is a clear connection between the turn to writing live interactive pieces and the introduction of MIDI tools. It is often supported by composers in their own words, other times apparent in the

[115] Including tape plus acoustic performer.

[116] Table 17.

[117] Table 16.

change of compositional output for 18 out of 45 composers. Of those who composed live music after their introduction to MIDI, 60% agreed to that statement.[118] 37% of composers attested that availability of MIDI had no impact on their preference in continuing to write live music.[119]

Meanwhile the number of composers who wrote tape pieces slightly decreased (to 84%) as some switched entirely to live interactive music. MIDI was used for the composition of tape pieces by 21 out of 40 composers who answered that question.[120]

For some composers the mere availability of MIDI tools could have no influence on the choice to write real-time interactive music.

> "I think there's too much of a premium put on real-time. The thing that's useful about it, in terms of real-time, is for performers. That you can bring an electroacoustic synth to a concert hall and this can be just another instrument... But composing is never real-time. [..] Compositionally, I don't care about real-time. That's the last thing I'm concerned about" (16:*B180).

Even a composer who composed live interactive pieces before MIDI could pass on the real-time interactive opportunities opening with MIDI, if his/her interest had shifted to other areas, or the circumstances were not in place.

> "I am very interested in live performance but very dissatisfied with the quality of the MIDI interface, the MIDI sounds and so I wouldn't go into that medium" (14:*A75). Later in the same interview, "The most limiting thing for me as a composer really dealt with the mechanisms of the time that were interfacing to the MIDI devices themselves. If you wanted to have realtime control, you had to rely on the sounds that were coming out of these synthesizers, that were just ugly sounds, I'm sorry. For those of us who have been synthesizing sounds for years and getting these glorious sounds because we could put random number generators, we had floating point calculations, we could do all these incredible things, when we heard MIDI orchestra instruments, we were horrified!" (14:*A290).

On the other hand, MIDI extended the possibilities for interaction in the performance for composers who had worked with real-time performance music before MIDI. For example, #4 who worked with the ensemble of synthesizers in the 70s and later went on to make tape music generated by the computer, returned to live interactive music with MIDI.

> "It is quite clear that what MIDI brought [...] was the capacity to come back to real-time and to have a certain amount of productivity, without caricature, nearly in the industrial sense. [Before MIDI] For 30 seconds of sound you would spend the night and that could have been only one layer of polyphony. All this was extremely demanding. With MIDI you could immediately have layers of polyphony and multitimbrality and some form of expressive control" (04:*B27).

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[118] *"Has availability of MIDI influenced your choice for writing live interactive music?"*

[119] Table 16.

[120] Table 17.

That experience is repeated by #31:

> "It got me back in performing, I'm more interested in the performance issues and what I could do with the live performance. Before that, my thinking was more along the lines of tape pieces, non-real-time issues, a little more pre-mediated composition. The ability to make use of this common interactive protocol led me in a different direction, in the direction of thinking of live performance issues and real-time interaction" (31:*A360).

Rowe divides the process of interaction with computer music systems into three stages: *sensing*, when the computer collects data from live performers, *processing*, during which received data is interpreted, and the *response* stage when the computer outputs the result into the system (Rowe, 9). MIDI equipment has significantly advanced the facilities for the first, sensing, and the last, result steps of interaction. "Commercial manufacturers dominate the sensing and response stages, through MIDI controllers and synthesizers. [...] The processing stage has commercial entries as well, most notably MIDI sequencers" (Rowe, 9-10).

MIDI allowed control of multiple instruments, computers, and even certain non-musical devices that had been a problem with the pre-MIDI equipment. A textbook on pre-MIDI electroacoustic composition, while encouraging the student to write for live situations, nonetheless cautions that "it is possible to coordinate live, real-time synthesis with other forms of live performance, including instruments, voices, visual media, or dance. The only problem that may arise in all of this is the incredible complexity that can result from trying to control the actions and interactions of many people simultaneously" (Naumann, 397-398).

The testimony below shows how MIDI made such control possible. Other important changes highlighted here are storage facilities leading to the new technique of working with and refining sound material.

> "Basically it {MIDI} made the XXX {e/a performance instrument} possible. That's a huge change, suddenly I could move around stage freely, didn't have to sit behind the machine, like in the piece now you can go into the hall, that wouldn't have been possible without MIDI. It allowed me to control different kinds of instruments at once without having to think; it allowed me to make presets so I didn't have to do all the setting first; it allowed me to edit sounds, to keep them, to call them back. [...] Now every recording in the piece we make is stored on the hard disk at the same time. So we start to have this collection of all these people that did these things during the concert. I reuse it, I filter out some material, I keep material... That's building up a history of the instruments in a musical way. [..] It's very nice that you can have now electronic instruments that also keep some of the special sounds and some of the unique sounds that occurred during concerts. All of this, of course, wouldn't be possible without MIDI, without computer technology" (23:*B220).

MIDI gave more independence to the performer during live interaction. "Many are enthusiastic about using MIDI to help move beyond the limitations of tape music. [...] Throughout my career in electronic and then computer music {before 1985}, little of substance could be done in live performance. Analog synthesizers offered real-time control, but over pathetically limited resources. Software sound synthesis offered tremendous resources, but none of it in real time.

Compositions for tape and live instruments usually required the live instrumentalists to synchronize their performance to the tape (unless one chose to declare that synchronization was unimportant, a limited aesthetic option). This made the live performers slaves to the tape part. Now at last we are in a position to make the performer the independent variable and the synthetic part the dependent variable. A whole continuum of possibilities has opened up" (Loy, 22).

The elevation of the status of live interactive electroacoustic music to that of a valid flourishing musical genre, on par with the electroacoustic tape tradition, showed distinction between the two practices and the differences in demands for each.

> "MIDI made it possible for me to do these interactive pieces. It also made me bang my head against these limitations of the control. I feel like I've done alright in that area, but it's a change in my focus -- when I do a MIDI piece I may be content to more or less use the sounds that are in the synthesizer with the few tweaks whereas when I'm doing a piece in software synthesis or real-time synthesis [..], some other medium, like Music Kit which combines both, I might be more concerned with the details of the sound than I would be in a MIDI piece. In a MIDI piece I am more concerned with the pitch structures. I wouldn't say it's somehow revolutionized my thinking, it's more like [that] the pieces I write for this medium have more of these characteristics, a concern with interaction for one thing. An interaction has a lot of interesting aspects such as the ones I was talking about: permeability between instruments, new concepts of form that are kind of improvised, autonomous processes in the computer that you interact with -- those follow from having interactive computers" (32:*A330).

Note the clarity of preference in the following excerpt:

> "I use MIDI when I need real-time performance nowadays. When I came here [CCRMA] for the first time I started using software synthesis. So, for anything that's not real-time, I just use software synthesis" (33:*A580).

Despite the significant advancement of facilities for live interactive music with MIDI, certain limitations remain.

> "For live performance I have to use MIDI. For example, in the kind of pieces I was doing lately [...], I'm using real-time continuous control of the sounds, timbre or filter settings. That means sending a lot of information through MIDI and it just doesn't work. I have to do fancy programming things just to get acceptable results. I don't get what I want, I get what I can get away with. I don't mind that in the sense that I don't hate MIDI, it's just a tool. When we have computers fast enough to do what MIDI's doing now in software, then I have absolutely no reason to go through MIDI" (33:*B390).

Respondent #42 points out connection between live performance tradition and availability of instruments:

> "For live performance there is really no very good alternative in my view. The Samson Box was a wonderful device. In fact it was designed to be a real-time performing device, the way it was used, however, was a real-time computing device. The reason, of course, was that if one had written a real-time performance piece for that, it would've had one

possible locale for performance - wherever the device was. And that's not the way we think about music normally, we think about music being performed in a variety of venues. So it was used to produce tapes which can be transported and played elsewhere. As it is today, the only viable real-time performance medium is the MIDI-based medium, because that's the only medium one would assume because that's the only place where one could assume that you have a device in Paris, Tokyo, Australia and the Arctic" (42:*A100).

"It {MIDI} provided the idea of ubiquitous instruments, as you can find them no matter where" (42:*B95).

This respondent points out differences in the interaction model between performers in pre-MIDI and MIDI environments.

"When I was working with the [analog] tape delay ensemble, I was interacting with another person and maybe two other people, or something like that. We would be together making the music as it happened. With the MIDI stuff I would be interacting basically by responding to a pianist, which was still making music but [in the] responses there was one step back, [..] you'd be tightly coupled in the first case, in this {MIDI} case I'd be surrounding the person who is making music. [..] Some of that, I think would be due to the nature of the tools being used. I suppose I could have done a collaborative MIDI piece where the two of us would be playing MIDI keyboards influencing each other. I took the easy road with MIDI, if there's notelists, I'll just make notelists, trigger them and turn them back. So there, I guess, MIDI did have an influence on how I approached it, because I thought of it in those terms. That was the path of least resistance too" (1:*A220).

The general trend is a boost in the popularity of live interactive forms with MIDI. However, there are still exceptions to the rule. The following excerpt shows use of MIDI (in the only MIDI project ever done) for a non-real-time tape piece by an otherwise interaction-oriented composer.

"The use of MIDI in this work is fairly minimal. If I remember right, I played a MIDI keyboard connected to a NeXT which captured timing and note information. I translated the note information into values that could be used in the filter program (octave per channel, I think) and took some of the timing values and used those in between changes in door direction. That's about it really. In a "hard to put my finger on it" way MIDI let me think about the compositional possibilities of the sounds of the door. Maybe MIDI facilitated a particular process but it is again hard to say. I didn't really need MIDI but maybe I wouldn't have taken that approach without it. The interesting thing here is that I see MIDI in a real-time paradigm and my work at that time was purely non-real-time. I'm not sure I ever reconciled this dualism" (8:*add1).

6.4 Role of Improvisation

Improvisation[121] has been a common music-making method but its implementation in pre-MIDI stages of electroacoustic music was problematic. "Live improvisation using computers and digital synthesizers, which was impossible just a few years ago (see Hiller and Isaacson 1959 and Hiller 1970 for a historical perspective) is now a hotbed of activity" (Music Machine, 63).

	Yes/ Better	No/ Worse	Same/ Mixed
Use of improvisation as part of compositional practice	23	22	0
Percentage 1	51	49	0
Facilities for improvisation with MIDI are better/worse than with pre-MIDI tools (of all)	15	0	2
Percentage 2	88	0	12
Facilities for improvisation with MIDI are better/worse (those who use improvisation)	13	0	1
Percentage 3	93	0	7

Table 18. ***Improvisation***

Half of the respondents in the survey reported using improvisation in their compositional practice.[122] All composers who answered the question consider MIDI facilities for improvisation better than the ones available before MIDI equipment. Of the 14 composers who actually employ improvisation in their works, the response is even better with 13:0 rating it higher than pre-MIDI. The only respondent who cited negative influence of MIDI for improvisation in his works attributed that to the switch in his interest to other possibilities of this MIDI environment, which does not directly deem improvisation possibilities as worse.

> "I used improvisation in my pieces a little bit more freely before MIDI because I became distracted by the precision of MIDI and didn't work with it a whole lot in the first few pieces that used MIDI. I think it had been a particular proclivity of mine that I got distracted by the precision and control when MIDI came along and left some interest in improvisation behind, temporarily" (18:*B190).

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[121] By *improvisation*, we meant musical output coming from a source not fixed in either written (precise score, computer program), or recorded form and constituting a significant part of the musical work.

[122] Table 18.

Extended control possibilities are highlighted in these excerpts:

> "The ease of control we gained with MIDI made live performance and improvisation along with it less unwieldy than it was with modular synths" (28:*add1).

> "Before MIDI I also used improvisation changing timbre of sound [...], after MIDI we can control more parameters of sound, not only the sound color but also phrases, dynamics, anything can be controlled by MIDI in improvisation" (10*A511).

> "[How would you compare MIDI to pre-MIDI possibilities for improvisation?] -Better. MIDI provides interoperability. While early MIDI devices didn't allow as much control over the sound itself as pre-MIDI analog synthesizers, each successive generation (especially from Yamaha) has increased the flexibility and control possibilities" (32:*add2).

Improvisation and interaction went hand-in-hand. Composers who focused on interactive real-time electroacoustic music benefited from availability of MIDI tools most.

> "The advantages [of improvising with MIDI] were pretty clear: first of all, the approach to instrument in the real-time which for me as a performer was interesting, and, secondly, the approach to artificial performer, which would be a software accompanist who's actually a software algorithm running in real time, receiving commands in real time and reacting to them. Those were the kind of things that you couldn't really explore over the paradigm of MUSIC V, batch processing" (13:*A230).

Computer/instrument interaction fared particularly well.

> "MIDI certainly is great in the extent [to which] it enables improvisers to communicate with the computers. I think that's certainly a whole new world" (24:*A395).

> "It's easier now because of personal computers, because you can program more flexibly. [...] The point is the software itself is generating information causing its user to improvise" (30:*A310).

In one particular case, dissatisfaction with voices available in MIDI instruments, in particular with the control at the microlevel (at the sound level), clashes with interest in real-time improvisation. However, availability of easy control on the macrolevel (between components of the setup) helped solve the problem.

> "Once you went to MIDI, the ways that things could be controlled were in fact shrunk. You only had controllers and mostly those were key-oriented. So there was less continuous control over parameters of the music you were making. That was problematic.[...] I usually found the way around that was to build something at a higher level into the software. Without the software, doing interactive things I wasn't so much interested in the sound that the instruments by themselves could make. I wasn't likely to buy a DX7 and improvise on a DX7 by itself. That didn't interest me musically. But controlling a DX7 and editing its voice parameters through a computer - that was more interesting" (40:*A450).

Not only the performer but also the computer was now enabled to improvise structures and parameters according to the real-time interaction.

"I really wanted [improvisation] in that piece (the only interactive MIDI piece) and I think I succeeded in developing the kind of improvisatory connection with some algorithm. I really liked the idea of the algorithm as a generator of a musical shape. I think the piece succeeded more when it was improvising its own alphabet" (24:*A475).

MIDI extended the range of timbral sources to be included into improvisatory performance.

"What's changed for me now is that there is a possibility of integration between environments, [e.g.] if I want to include pre-calculated sounds, audio files, along with interactive MIDI kinds of things. That expands the synthetic possibilities because I'm back to general purpose environment computing sound, so it kind of fixes one of the limitations. The advantages have increased. [..] For me it's more 'Yeah, I can do MIDI plus I can do processing of whatever, using DSP in real time, mixing it with audiofiles in real time', to me that's the orchestra" (13:*A238).

MIDI also allowed real-time inclusion and control of mixing and effect devices into the improvisation process. "[Comparing MIDI to pre-MIDI facilities for improvisation] -A lot more diverse post-MIDI. Controlling mixers and processors via MIDI is a big difference, for example" (34:*add5).

MIDI equipment allowed storage and repeat facilities for improvisation that pre-MIDI tools did not have. Those are essential for analysis and selection of improvisationally generated material.

"If I have a good way of taking the good ones or the interesting finds and putting them in my bag, I can start to study what things they can suggest about music, about the formal result of the piece, how they combine with each other. It's very very crucial to do that, to be able to go back to the thing you've found. This is a really important point of working with MIDI, I discovered later. If I improvise in a certain way with these big knobs exploring the space of some algorithm, it's quite possible I get a good one and then I want to hear that again I can't find. [...] It (the control system) has to be repeatable, you have to be able to go back to it and then make variations of that" (13:*A350).

Extended possibilities for improvisation with MIDI encouraged other composers who did not use improvisation as a compositional method before to use it now with MIDI.

"Improvisation. If you think of improvisation being spontaneous composition, then I'm more interested in that [since introduction of MIDI]. [MIDI] allowed a real-time interaction with the computer so I became interested in how I can set up a system that'd make my performances larger than life" (31:*B60).

6.5 MIDI Notation Facilities

Despite the existence of many practices contradicting traditional conventions of Western art music, e.g. acoustic instruments, notes, live performance, orchestral parts etc..., the absolute majority of interviewed electroacoustic composers (76%) acknowledge use of notation as part of their compositional method. More strikingly, 63% have used traditional notation for the

composition of electroacoustic music.[123] Alternative systems of notation which include the use of graphic (non-traditional), computer code, physical value, and verbal command representations of music have been employed by 44% of composers. The overlapping margin of those two groups is quite high -- one-third of the composers whose answers are available used both traditional as well as alternative notation systems.[124]

	Yes				
	All	Traditional	Alternative (graphic, software code, verbal, physical value)	Both (overlap)	No
Use of written notation	31	26	18	13	10
Percentage	76	63	44	32	24

Table 19. ***Use of Written Notation***

Software applications for scoring had been in existence since the early 1970s.[125] Focusing on fast transfer of information between compatible computers and digital instruments, MIDI protocol was bound to foster the development of scoring on-line. Notation packages were among the few MIDI applications developed directly for professional musicians. The MIDI note-oriented approach fit perfectly into note-oriented compositional practice: the input of notes was greatly simplified, the response time for trying out the sketch minimal, and user-friendly approach of contemporary digital equipment was helpful. In that regard MIDI software has been revolutionary.

> "MIDI has been in many areas, but all these areas related to notes. For example... manipulating scores [..] all the score-editors were coming after MIDI. Before MIDI the operation of extracting notes, or manipulating notes was something very very complicated. [...] With MIDI you have this very easy, you can make a MIDI file, you can make a process, you can make a MIDI file of this process, export to another program to do something else, then export to another program to do something, then export another MIDI file to make a score, and if you want, this score is played by an instrument or if you want, this score to CMusic or CSound to make a synthesis process with this" (44:*A31).

- How well does it reflect the often texture-oriented electroacoustic music, the kind of music which often does not imply the very concept of notes or instrument parts?

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[123] Table 19.

[124] Table 19.

[125] Since 1985, Computing in Musicology has canvassed around 80 developers of notation software. The survey respondents are apparently not well well-informed of existence of various notation packages. There is no real proof that MIDI speeded up notation in all areas of the field: large production houses favor SCORE and DARMS, both of which are non-MIDI software programs.

According to the results of the survey, only 44% of surveyed composers actually used MIDI notation software. The percentage is higher (50%) among those who used traditional notation for their written scores, and lower among the users of alternative written systems.[126] This paints a picture of neither prevalent rejection, nor prevalent acceptance, but rather a collage of both met and unfulfilled demands.

	Yes			
	All	those using traditional notation	those using alternative notation	No
Use of MIDI notation	19	13	7	24
Percentage	44	50 (of this group)	39 (of this group)	56

Table 20. ***Use of MIDI Notation Software***

MIDI software was developed with the traditional conventions in mind: notes, meter, parts etc. In this particular example, MIDI notation software perfectly fits into writing for orchestra.

> "It {using Finale} is a practical thing. For example, in orchestral or ensemble works, you have to score, and then make the parts from the score. It means that you don't normally add more mistakes. If there are mistakes, they are the same in the part and in the score. It's practical in my field. Also it's less tiring for the hand, I have a big problem writing big pieces, I got a kind of tennis elbow problem" (20:*A540).

Computer keyboards, synthesizers, or any MIDI controller could now be used for entering key numbers and other note-describing, MIDI-understandable values into the score. "It was definitely beneficial there because you had several ways of entering material, not just the pencil or the mouse. Yes, that was definitely beneficial" (43:*B565).

MIDI provided communication lines which make it possible for the score being created to be played on a MIDI instrument, even if that instrument is not the final sound source for the piece. That significantly expanded possibilities for ***proofing*** the score.[127]

> "Computer notation and, of course, MIDI note input, certainly, that's a profound revolution. [Also] I'm using MIDI for proof-listening to a score. It's a fabulous example of the great service that MIDI has made to composers and musicians" (18:*B40).

The following excerpt gives an example of Finale's higher speed of scoring makes it advantageous. It also shows how MIDI-controlled scoring becomes part of the larger setup in the compositional practice.

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[126] Table 20.

[127] Obviously only when notation software could be used to create the desired score in the first place.

"It was less time-consuming, I could write pieces more quickly, immediately. After I figured out these techniques of working around MIDI to make it do what I wanted, then everything was much quicker. All the way to the point when I had to do a trumpet and tape piece about 2 years ago for a commission, they wanted it in 5 weeks for the trumpet player to learn it. I would've never done that, it could take me months to write a piece before that, months and months. I said yes and took the challenge and I was able to do the piece in 5 weeks. I have a bank of ideas, and timbres and the ways of working, in the studio from years of working, and I didn't try to do anything I had never done and I was able to notate the trumpet part, and part of the tape part and make a template, using Finale. Then, as a standard MIDI file, drive all this other stuff and use that as a starting, jumping off point of piece. So, there's an example -- it made things much, much faster" (28:*B80).

Here is an example of a respondent who has worked extensively with software synthesis but never used MIDI notation software (although aware of it). His rejection comes as the reaction to the note paradigm constraint.

"I am aware of the fact that some of these programs have limitations. [...] I don't like the idea that you are constrained not to do this or that. I think these programs are very important. [..] [It's] something that I would very much like and probably will do that. But notation, especially, rhythmic notation raises the problem. The pitch is not, because it is quantized by the keyboard,[128] but the rhythmic result depends on how you make your quantization, how strictly you play the rhythm, so I have not used this very much. I realize it's an important field and I'd like to use some aspects of it, but I haven't really done it in any significant way so far" (38:*C270).

The following respondent shows how the complexity of Finale by being an obstacle to expressing the compositional ideas paradoxically enforces simplification.

"What is difficult in Finale is not writing the pitches but writing the nuances, the shades, the slurs and things like that, [..] you have a lot of notation of many sorts, eventually, after awhile you're fed up and you don't do it. There's a process of unwanted simplification from the point of view of the banal standard, and I really don't want to go through. I think this is a danger. Very often when composers who start to write with Finale, start to write simpler" (17:*B120).

Learning MIDI notation software is recognized as a time-consuming process.

"I never quite used them {notation programs}. Perhaps it came too late for my own development. At the time I was too busy I didn't really want to invest time in that. [...] I realize the more power the program has, the more investment you must make into learning it" (38:*C270). "I wanted to use it, [but] it's too big an endeavor to do it. I have three elements against this, against my not investing several months into learning Finale..." (17:*B120).

[128] Pitch is not quantized by the keyboard. The term *quantization* usually refers to the process of rounding up real-time input values (often rhythm) to the closest scale value, for example, to the durations of a fourth, eighth or sixteenth notes. I suppose the respondent meant to emphasize the set pitch vs. unconstricted rhythmic duration -- the default setting of many MIDI devices.

Not everyone found learning it tedious, but expressing compositional ideas in this environment was not easy.

> "I found them {notation programs} easy to learn, but implementing them, really making them more compositional, was more of a challenge. I think they were designed for something other than the way I'm used to working in so I had to find lots of ways to work around it. The initial learning curve was harder, figuring out how I can make it do what I want was harder initially" (28:*B80).

Finale and other MIDI software used an analytical approach to score writing where a value would be determined before the process of score creation starts. "I haven't paid attention to it {MIDI notation}. I simply didn't want to take the time for it. I tend to work more from intuition, rather than analytically" (37:*B190).

The general approach, popular in art music of the 20th century, which eradicates limits of pitch, duration, and score conventions was sure to clash with MIDI constraints. The development of computer graphics gave birth to programs allowing the user to essentially paint any kind of scores on staff by using either ready-made symbols, or creating their own. Obviously, such demands could not fit into MIDI limitations which deprived these programs of the benefits of MIDI software discussed above. Nonetheless, if MIDI was not a necessary element of compositional practice, non-MIDI notation software allowed its users to do well without it.

> "I hate Finale, it's a totally stupid program which one uses for the variety show music. But I use NoteWriter, it's a very flexible program which allows me to create my score as I want. Finale is a completely fascist program, NoteWriter is a completely liberal program. I don't write with the computer. [So, did MIDI software help you?] -Not MIDI, NoteWriter is non-MIDI" (36:*B75).

6.6 Change of Compositional Interest

Only 8 composers (22%) have changed their focus of compositional interest in electroacoustic music from one property to another in transition from pre-MIDI to MIDI environments, whereas 28 (78%) did not.[129] It shows that despite the profound change in the tools, the core of the compositional activity remains the same. The tenacity with which the composer's style persists is indirectly supported by the overwhelming number of composers who decided to transfer pre-MIDI practices into their MIDI works.

> "I had evolved stylistically as a composer to the point when I was consistent before MIDI came along. I don't think MIDI has created any change in me stylistically as a performer or a composer" (29:*C390).

[129] Table 21.

	Yes	No
Change in the focus of compositional interest (in transition from pre-MIDI to MIDI tools)	8	28
Percentage	22	78

Table 21. ***Change in the Focus of Compositional Interest***

The eight composers who did switch demonstrated the shift in interest to those aspects of composition that were greatly expanded by MIDI tools: interactivity, improvisation, and control.[130]

[130] See Appendix F.

Chapter 7

Conclusions

The introduction of all-digital MIDI-based technology was not a mere change in the continuum of development of electroacoustic music technology, but much more a ***technological revolution*** in the tools used for composition. The extinction of analog devices came as one of the major effects of this revolution. The birth of new paradigms of instrument design, compositional environment and performance solutions were also significant.

This revolution was neither anticipated, nor precipitated by the electroacoustic art music community. Some features of MIDI technology had been available before its introduction, but the expectation of art music composers was turned in a different direction -- towards the real-time digital signal processing systems. The inter-device compatibility problem, to which MIDI was a solution, did not manifest itself much in the experiences of art music composers. This community was not involved in the main course of development of MIDI and its participation in the development of extensions of the protocol was minimal. MIDI, as it is clearly shown in the results of the study, was imposed on the community although the results of such an imposition were often very positive.

The positive reception of MIDI has increased from a little over a half at the initial point of introduction to four-fifths at the end of the surveyed period. Despite the instant availability of information and tools, the process of adaptation to the new tools took much more time. By now, the absolute majority of composers have used MIDI in their works, with the majority of MIDI users employing it on a regular basis. However, the majority of composers have also continued to use exclusively non-MIDI environments.

The interaction between composers and MIDI tools is always a compromise between demands of the individual style and advantages and limitations of the MIDI equipment. *Advantages* of the protocol (its real-time communication, compatibility between the tools, control capabilities and precision) contrasted its *limitations* (event-oriented paradigm, low data transfer rate, fixed scales of values and one-way communication limited in the number of channels). The features of the protocol were implemented into the design of the MIDI instruments and combined with other technologies, not directly related to MIDI. Often the same feature could be both limiting to one

composer and beneficial to another. That shows that the use of the tools was the result of the balance of the compositional goals and experiences of a particular composer and the capabilities of the tool. In some cases the limitations of MIDI equipment and satisfaction of working with non-MIDI environments has led to the total exclusion of MIDI from the compositional setup. Control over the development of continuous processes, a staple in pre-MIDI electroacoustic music, is particularly problematic with MIDI. The technological tradeoff made for the sake of enhanced user-friendliness and affordability in the larger commercial market limited synthesis capabilities and access and therefore disappointed some composers. However, one can see the emergence of new methods, new practices and new performance solutions that were not present in the pre-MIDI era.

The relative democratization of electroacoustic music is clearly one of the positive effects of MIDI revolution. The affordability of the new set of tools led to the appearance of home computer/electroacoustic music studios. MIDI also had a positive effect on concert practice. Also, MIDI marked the beginning of active commercialization of the field.

About half of the surveyed composers had practiced some kind of live (non-tape) music before MIDI. MIDI gave a boost to this genre, providing reliable, portable, storable devices and connections and raising the number of composers involved into live interactive music. MIDI environments have also greatly enhanced opportunities for improvised interactive composition. Meanwhile, tape pieces have continued to be the principal performance genre among the art composers just as software synthesis continued to be the major source of timbres after the introduction of MIDI. Almost half of the respondents have used MIDI-controllable ready-made sounds. The evaluation of these preset synthesized sounds in MIDI instruments is unfavorable. In particular, the opinion on the quality of acoustic simulation in such sounds is utterly negative.

As our study has shown, the influence of MIDI is multifaceted. The respondents constituting the studied group have been professionally active as the composers of the electroacoustic art music before and after the introduction of MIDI. Even in a group as narrow as the one surveyed, the range of responses is striking. The conflict between the origins of MIDI and the pre-existing compositional practice has not been entirely solved. Instead the results show the ***incorporation*** of the new tools into the existing tradition, ***compromise*** in some elements of interaction, ***rejection*** of others and ***development*** of new practices.

The tenacity of tradition went against the drastic change of tools. The conclusions above show how the pre-MIDI genres and the timbral sources have continued to dominate in this period as well. The majority of art music composers have attempted to transfer their pre-MIDI compositional methodology and practices into their MIDI works. Most of them succeeded in this transfer.

The switch to the new set of tools caused a change in compositional interest from one property of electroacoustic composition to another in less than a one-fourth of the surveyed composers; however, stylistic changes are numerous and vary from composer to composer. Manifestations of

that are seen in all steps and elements of compositional process from organization of this process to changes in the structure of MIDI-based pieces. Distinct changes in the produced musical output appear as a result of such influence.

These results lead us to conclude that **the adoption of new technology had no effect on the core of the compositional style of the majority of composers, whereas at the level of technical detail there are abundant examples of changes to the details of methodology**.

Appendix A

List of Composers Interviewed in the Study

Marc Battier
Jean-Baptiste Barriere
Marcia Bauman
Chris Brown
Joel Chadabe
Chris Chafe
Eric Chasalow
John Chowning
Luc Ferrari
Guy Garnett
Brad Garton
Johannes Goebel
Jonathan Harvey
Daid Jaffe
Kare Kolberg
JoAnn Kuchera-Morin
Paul Lansky
Cecil Le Prado
George Lewis
Cort Lippe
Fernando Lopez-Lezcano
Philippe Manoury
Michael McNabb
Tristan Murail
Pauline Oliveiros
Peter Otto
Maggi Payne
Stephen Pope
Alistair Riddell
Jean-Claude Risset
David Rosenboom
Kaija Saariaho
William Schoettstadt
Barry Schrader
Stanley Shaff
Carl Stone
Allen Strange
Marco Stroppa
Morton Subotnick
Barry Truax
Kazuo Uehara
Horacio Vaggione
Michel Waiswisz
David Wessel
John Young

Appendix B

The Statistics File

The citation numbers, otherwise included in all appropriate cells, as well as the topics which had only citation tag numbers in the file[131] and no statistical values,[132] for example, "Listed limitations of MIDI protocol", or " Perceived stylistic changes in music as influenced by MIDI" have been removed from this chart for the sake of clarity.

[131] For example (3:*A45).

[132] For example, 'yes'; negative' etc...

(Appendix B cont.)

	Topic
1	Used MIDI (n -no; c- common use of MIDI; r-rare use of MIDI)
2	Used non-MIDI environments after introduction to MIDI
3	Wrote pieces for live/interactive performance before MIDI
4	Wrote pieces for live/interactive performance with MIDI
5	Availability of MIDI tools influenced the choice for writing live interactive vs. tape pieces
6	Used computer (software, algorithmic) environments for composition before MIDI
7	Used non-computer (tape manipulation; synthesizer) timbral sources before MIDI
8	Wrote tape pieces before MIDI
9	Wrote tape pieces after introduction to MIDI
10	Used MIDI for writing tape pieces
11	Initial reaction to MIDI (pos-positive; neg-negative; mix-mixed)
12	Evaluation of MIDI changed over the years
13	Change of evaluation (pos-positive; neg-negative)
14	Year of the first MIDI piece
15	Expected the appearance of a digital control standard like MIDI in the mid-1980s
16	Experienced problems due to incompatibility of the pre-MIDI hardware
17	Attempted to fix them by connecting, cross-patching those incompatible components
18	Year of introduction to MIDI
19	Attempted to transfer pre-MIDI compositional methodology and practices
20	The transfer was successful (y-yes; n-no; part-partially)
21	Developed devices, elements before MIDI later abandoned or replaced with the MIDI ones
22	Has pieces different versions of which are written using MIDI and non-MIDI tools
23	Developed original computer-based timbres before MIDI
24	Developed original computer-based timbres after introduction to MIDI
25	Used MIDI presets
26	Attitude towards the use of MIDI presets (pos-positive; neg-negative; undef-undefined)
27	Satisfied with the quality of simulation of acoustic instruments in MIDI presets
28	Improvisation is an important part of the compositional method
29	Comparing MIDI to pre-MIDI possibilities for improvisation
30	Kinds of notation used (tr-traditional, gr-graphic, syn-syntactic, comp-computer code; ab-abstract)
31	Used MIDI notation software
32	MIDI tools were easy to learn, install, implement into the composition environment
33	Comparing the user-friendliness of MIDI equipment to pre-MIDI tools
34	Comparing social accessibility
35	Noticed a shift inthe primary focus of composition from one property of style to another
36	Perceived conncetion between the use of MIDI tools and the form of the MIDI pieces

(Appendix B cont.)

	01	02	03	04	05	06	07	08	09	10
1	r	c	c	c	c	c	r	r	c	c
2	y	y	y	y	y	n	y	y	y	y
3	y	y	y	y	n	y	n	y	n	y
4	y	y	y	y	n	y	y	n	y	y
5	y	n/a	n	y	n	y	y	n	y	n
6	y	y	y	y	n	n	y	y	n	n
7	y	y	y	y	n	y	y	y	y	y
8	y	y	n	y	y	y	y	y	y	y
9	y	y	n	n/a	y	y	y	y	y	y
10	n	n/a	n	n	y	y	n	y	y	y
11	neg	neg	pos	neg	pos	pos	neg	neg	neg	pos
12	y	y	y	y	n	n	n	y	n	y
13	neg->pos	neg->pos	pos->neg	neg->pos	n	n	n	neg->pos	n	pos->pos
14	1988	1989	1985	1984	1987	1987	1987	1990	1989	1986
15	n	n	n	n	n	n	y	n	n	n
16	n	y	y	y	y	n	y	n	y	y
17	n/a	n	n/a	y	n	n	n	n	y	y
18	1984	1983	1983	1983	1985	1986	1984	1984	1983	198
19	y	n	y	n/a	n	y	y	n	y	y
20	y	n/a	y	n	n/a	part	y	n/a	y	y
21	n	n	n	n	n	y	n	y	y	y
22	n	y	n	n	n	n	n	n	y	n
23	y	y	y	y	n	y	y	n	y	n
24	y	y	y	y	y	y	y	y	y	y
25	y	n	y	y	y	n	y	n	n	y
26	pos	pos	pos	pos	pos	neg	neg	undef	neg	pos
27	mixed	n	n	n	n	n	n	n/a	n	n
28	n	n	n	n	y	y	y	y	n	y
29	n/a	n/a	n/a	n/a	better	better	n/a	n/a	n/a	better
30	n	tr	gr, tr	n	gr, tr	comp, tr	tr, gr, syn	tr	tr, gr	tr, gr
31	n	y	n	y	y	y	y	y	n	y
32	y	y	y	y	n	y	n/a	y	y	y
33	worse	worse	better	worse	better	w	better	n/a	mixed	worse
34	n/a	n/a	no chang	n/a	n/a	better	no chang	no chang	better	better
35	y	n	n	n	n/a	y	y	n	n	n
36	y	n/a	n	y	n	n	y	n	y	y

(Appendix B cont.)

	11	12	13	14	15	16	17	18	19	20
1	c	n	c	n	c	n	r	c	r	r
2	y	y	n	y	n	y	y	n/a	y	y
3	n	n	n	n	y	n	n	y	n	n
4	n	n	y	n	y	n	y	y	n	n
5	n	n	y	n	n	n	y	n	n	n
6	n	y	y	y	y	y	y	n/a	y	y
7	y	n	y	n	y	y	n	y	y	n
8	y	y	y	y	n	y	y	n/a	y	y
9	y	y	y	y	n	y	y	n/a	y	y
10	y	n/a	y	n/a	n	n/a	y	n/a	y	n
11	neg	neg	pos	neg	pos	neg	pos	pos	neg	neg
12	y	n	y	n	n	n	y	y	y	y
13	neg->pos	n	pos->pos	n	n	n	pos->neg	pos->pos	neg->pos	neg->pos
14	1991	n	1987	n	1984	n	n/a	1986	1992	c.1991
15	y	y	n	n	n	n	n/a	n/a	n	n
16	n	y	y	n/a	y	n	n	y	n	n
17	n/a	n	n	n	n	n	n/a	y	n	n
18	1986	1983	1983	1984	1983	1983	1983	1983	1984	c.1985
19	n	n/a	y	n/a	y	n/a	y	y	y	n
20	n/a	n/a	y	n/a	y	n/a	n/a	partially	y	n/a
21	n	n	n	n	n	n	n	y	n	n
22	n	n/a	n	n/a	n	n/a	n	n	n	n
23	n	y	y	y	n	y	y	y	y	y
24	n	y	y	y	n	y	y	y	y	y
25	n	n	n	n/a	y	n/a	n	n	n	y
26	neg	neg	pos	neg	neg	neg	neg	neg	neg	neg
27	n/a	n	n	n	n	n	n	n	n	n
28	n	y	y	n	y	n	n	y	n	n
29	n/a	n/a	better	n/a	better	n/a	n/a	n/a	n/a	n/a
30	gr	tr	tr, gr	trad	n	gr	syn	tr, gr	n	tr
31	n	n	n	n	n	y	n	y	n	y
32	n	n/a	n	n/a	n	n	n	n	y	y
33	worse	worse	better	better	better	worse	better	mixed	worse	better
34	n/a	no chang	better	better	better	no chang	better	n/a	better	better
35	n	n/a	n	n/a	n	n/a	n	n/a	n	n
36	n/a	n/a	y	n/a	n	n/a	n	n/a	n	n

(Appendix B cont.)

	21	22	23	24	25	26	27	28	29	30
1	c	c	c	r	c	n	r	c	c	c
2	n	n	n	y	n	y	y	n	n	n
3	y	n	y	n	y	n	y	n	y	y
4	y	n	y	y	y	n	n	n	y	y
5	y	n	n	y	n	n	n	n	n	n
6	y	n	n	y	y	y	y	n	y	y
7	y	y	y	n	y	n	n	y	y	y
8	y	y	y	y	y	y	y	y	y	y
9	n	y	n	y	y	y	y	y	y	n
10	n	y	n	n	y	n	n	y	y	n
11	pos	neg	pos	pos	pos	neg	neg	pos	neg	neg
12	n	y	n	n	n	n	y	n	y	y
13	n	neg->pos	n	n	n	n	neg->pos	n	neg->pos	neg->pos
14	1985	1991	1984	1989	1985	n	1986	1988	1985	1987
15	n	n/a	n	y	n	n	n	n	n	n
16	n	n	n	n	n	n	n	y	n	n
17	n	n/a	n/a	n	n	n/a	n	n	n/a	n
18	1984	1989	1984	1984	1985	1984	1984	1984	1984	1984
19	y	n	y	y	y	n/a	y	y	y	n
20	part	n/a	y	n	y	n/a	y	y	y	n/a
21	y	n	y	n	n	n/a	n	n	y	y
22	n	n	n	n	n	n/a	n	n	y	n
23	y	n	n	y	y	y	y	n	y	y
24	y	n	n	y	y	y	y	y	y	n
25	y	n	n	y	y	n	n	y	n	y
26	undef	neg	neg	neg	neg	neg	neg	neg	neg	neg
27	undef	n	n	n	n	n/a	n/a	n	n	n
28	n	n	y	y	y	n	n	y	n	y
29	n/a	n/a	n/a	better	better	n/a	same	better	n/a	better
30	tr	n/a	tr, gr	tr	n	n/a	n	tr	gr, tr	n
31	y	n	n	y	y	n	n	y	n	n
32	n	n	y	y	y	n/a	y	y	y	y
33	better	worse	better	worse	worse	n/a	worse	worse	worse	better
34	no change	n/a	n/a	better	better	better	better	better	worse	better
35	n	n	n	y	n	n/a	n	n	n	n
36	n	n	y	y	n	n/a	n	n	y	y

	31	32	33	34	35	36	37	38	39	40
1	c	c	c	c	c	c	c	r	c	c
2	n	y	y	y	y	n	n	y	n	n
3	n	y	n	n	n	n	n	y	n	y
4	y	y	y	y	y	n	n	y	n	y
5	y	y	y	y	y	n	n	y	n	n
6	y	y	n	y	y	n	n	y	n	n
7	n	y	y	n	y	y	y	y	y	y
8	y	y	y	y	y	y	y	y	y	y
9	y	y	y	y	y	y	y	y	y	y
10	y	n	n	n	n	y	y	n	y	y
11	pos	neg	pos	neg	pos	pos	pos	pos	pos	pos
12	n	y	y	y	n	n		y	n	y
13	n	neg->pos	pos->pos	neg->pos	n	n		pos->pos	n	pos->neg
14	1985	1991	1985	1985	1988	1988	1984	1984	1984	1984
15	n/a	n	n/a	n	n	y	n	n	y	n
16	n	n	n	n	n	y	y	y	n	y
17	n	n	n	n	n	n	n	n/a	n	y
18	1984	1983	1983	1984	1988	c. 1985	1983	1983	1984	1984
19	y	n	y	y	n	y	y	y	y	y
20	y	n/a	y	part	n/a	n/a	y	y	y	y
21	n	n	n	y	n	n	n	n/a	y	y
22	n	n	n	y	n	n	n	n	n	y
23	y	y	n	y	y	n	n	y	n	n
24	y	y	y	n	y	n	n	y	n	n
25	n	y	n	y	y	y	y	n	n	y
26	neg	pos	neg	pos	pos	neg	undef	undef	neg	pos
27	n/a	n	n	n/a	y	n/a	n	mixed	n	n
28	y	y	y	n	n	y	y	n	n	y
29	better	better	better	better	n/a	n/a	n/a	n/a	bet	better
30	n	tr	tr	tr	tr, gr	tr, gr	syn	gr, comp	n	tr
31	n	n	n/a	y	n	n	n	n	y	y
32	n/a	n	n/a	n	y	y	n	y	y	y
33	worse	worse	worse	better	better	better	worse	better	worse	better
34	better	n/a	better	better	better	better	better	better	better	better
35	y	y	n	y	n	n/a	n	n	n	y
36	n/a	y	n	n	n	n	n	y	n	n/a

	41	42	43	44	45
1	r	r	c	c	c
2	y	n	y	y	n/a
3	y	n	y	n	y
4	y	y	y	y	y
5	n	y	n	y	y
6	y	y	n	y	y
7	y	n	y	n	n/a
8	y	y	y	y	y
9	y	n	y	y	n
10	y	n	y	y	n
11	neg	pos	neg	pos	pos
12	y	n	y	n	n
13	neg->pos	n	neg->pos	n	n
14	1989	n/a	1984	1991	n/a
15	n	n	y	y	n/a
16	n	n	n	n	n
17	n	n	y	n	n/a
18	1984	1984	1984	1983	1984
19	y	y	y	y	n/a
20	y	n/a	n	part	n/a
21	y	n	y	n	n/a
22	n	n	y	n	n/a
23	n	y	n	y	n/a
24	n	y	y	y	n/a
25	n	y	n	n	y
26	neg	pos	neg	pos	pos
27	n	mixed	n	n/a	n
28	y	n	y	n	y
29	n/a	n/a	n/a	n/a	n/a
30	n	n/a	tr, ab	tr	n/a
31	n	n	y	y	n/a
32	y	y	y	y	n/a
33	better	better	worse	better	worse
34	n/a	better	better	n/a	n/a
35	n	n	n	n/a	n/a
36	n	n/a	n	n	n/a

Appendix C

Presentations of MIDI-Related Products in the Computer Music Journal

Products of interest. -- The MIDI standard; Yamaha digital synthesizers. *Computer Music Journal*, 7(4), p.73, Cambridge, Mass.: MIT Press, 1983.

Products of interest. -- Sequential Circuits MIDI sequencer. *Computer Music Journal*, 8(2), p.71, Cambridge, Mass.: MIT Press, 1984.

Products of interest. -- Synergy Plus digital synthesizer; MIDI Processing Unit from Roland. *Computer Music Journal*, 8(3), p.98, Cambridge, Mass.: MIT Press, 1984.

Products of interest. -- Roland MIDI Box; Software for Apple Macintosh computers; Sound Composition Systems serial-to-MIDI converter; Yamaha computer music products. *Computer Music Journal*, 8(4), pp. 75-81, Cambridge, Mass.: MIT Press, 1984.

Products of interest. -- PPG Waveform synthesizer; E-Mu Emulator II; Beilfuss Performance synthesizer; Analog-to-MIDI interface. *Computer Music Journal*, 9(1), pp. 72-81, Cambridge, Mass.: MIT Press, 1985.

Products of interest. -- Computer-to-MIDI interface by Hinton Instruments; Software for DX-7; Roland SMPTE/MIDI Synchronizer Box; WERSI Digital Keyboard Instrument; Low-Cost SMPTE timecode system; MIDITRACK Atari/MIDI sequencer; Personal Composer; IBM PC interface and software for Voyetra Synthesizer. *Computer Music Journal*, 9(2), pp. 71-79, Cambridge, Mass.: MIT Press, 1985.

Products of interest. -- Yamaha computer music products; Roland Standard MIDI Song Format; Sound Designer for Emulator II and Macintosh; SBX-80 SPTE Synchronizer Box. *Computer Music Journal*, 9(3), pp. 87-93, Cambridge, Mass.: MIT Press, 1985.

Products of interest. -- MIDI interface for the Radio Shack Color Computer; MIDI Interface for the Apple Macintosh; Total Music software; MIDIMAC; Lync performance keyboard; MIDI support for Decillionix; Fairlight CMI series III; Korg digital MIDI recorder with disk; Korg DW8000 digital synthesizer; Octave-Plateau Sequencer Plus for IBM PC; Moog Song Producer for Commodore computers; Synclavier II updates; Programmable digital Metronome/ Synchronizer; Yamaha products. *Computer Music Journal*, 9(4), pp. 74-85, Cambridge, Mass.: MIT Press, 1985.

Products of interest. -- IVL Pitchrider products; Linn 32-track MIDI sequencer; Prophet 2000 digital sampling keyboard; Cherry Lane Technology software; Fairlight Voicetracker; Deluxe Music Construction Set for the Macintosh; Octave-Plateau MIDI interface for IBM PC; DX/TX for IBM PC; MIDI Ensemble for IBM PC; Armonyx digital synthesizer for IBM PC. *Computer Music Journal*, 10(1), pp. 106-115, Cambridge, Mass.: MIT Press, 1986.

Products of interest. -- Promidi software; Prophet VD digital synthesizer; Prophet 2002 Rackmount digital sampling synthesizer; Roland digital piano sound module; Sound Designer 2000; Korg DVP-1 Digital Voice Processor; Korg SG-1 Sampling Grand; Mirage digital multi-sampler; Korg DSS-1 sampling synthesizer and updates; Personal Composer version 2.0; Tecmar music synthesizer for IBM PC; Casio digital synthesizers; Syntech keyboard controller for Commodore 64. *Computer Music Journal*, 10(2), pp. 87-93, Cambridge, Mass.: MIT Press, 1986.

Products of interest. -- MIDI interface for Apple IIC; Roland digital pianos; Yamaha CX5M upgrades; Patch Master; Hohner MIDI Reverberation/Echo; Dynacord MIDI controller; New products from Akai; Synthestra software of Decillionix; REV-7 Digital reverberator from Yamaha; Lexicon digital effects; Memory Resident DX/TX Librarian and Voice Editor. *Computer Music Journal*, 10(3), pp.103-113, Cambridge, Mass.: MIT Press, 1986.

Products of interest. -- Casio CZ-1 and AZ-1; Sampler for Commodore 64 and 128 Computers; PPG Realizer and HDU; Tecmar music synthesizer for IBM PC; Southworth JamBox 4; Yamaha MIDI products; Kurzweil K150 MIDI Expander and MIDIBoard; Rhythm Stick MIDI controller; Intelligent music software. *Computer Music Journal*, 10(4), pp. 96-106, Cambridge, Mass.: MIT Press, 1986.

Appendix D

Testimonies from Two Composers, Independent in Early MIDI Years

The following two testimonies came from composers who started their career independently and continued to work unassociated with any academic institution during early MIDI years. The similarity of their experiences is striking as they were far apart geographically. Working independently involved a lot of building of self-made instruments since pre-MIDI synthesizers and studio computers were out of reach and even MIDI equipment was barely affordable.

> "At that time {pre-MIDI} I was supporting myself doing odd jobs [...] and doing music in whatever time I could find, so electronics were originally cheap media for making interesting music, I thought. [...] You could go buy surplus electronics and build your own filter, oscillator, those kinds of things [...] That was all cheap that's why I got into it. Eventually I would look at Buchla or a Moog and say I wish I had that stuff but that was too expensive for me. [...] At the time they [MIDI devices] were a little bit more expensive. I felt that they were enough of a different way of working but I needed to have them and I [had] to get the money. They were a little bit more expensive [than now] but I was moving up, I started to be able to afford them. They were still cheaper than high-end computer music systems, in that sense they were more accessible to me" (40:*A395).

> "I started getting my first personal computers. The first one I used for musical applications was TI-99/4 which was a small home computer that Texas Instruments made. It had three square wave generators and it had a small plug-in module with the program that would allow you to control through envelopes both amplitude and pitch. You could write, actually, trajectories for pitch and amplitude for those three generators. [...] The one thing that made a big difference was I got a Commodore 64. That's another small computer; at the time it was quite powerful. For a game machine at that time it had a pretty sophisticated sound subsystem. There were three oscillators, one filter, I had different waveforms and several programs that enabled me use that as a kind of synthesizer. So I experimented with that for a while. After a while what I did was to build my own MIDI interface to it. I bought a Casio ZZ-101, which I think was one of the first affordable digital synthesizers available on the market. At that point the industry was making transition from the monophonic synthesizer, patchcord programmable, to a microprocessor controlled MIDI interface synthesizer, 1984-85, [...] reasonably priced under $1500. [Yamaha DX-7?] -That was much more expensive. At that point it was not possible for me to buy one. [...] Finally what I did was to buy this Casio synthesizer and

build the small MIDI interface for the Commodore-64. That combination made a big difference for me, mostly because I could get repeatable results. [On Commodore] there was a very nice sequencer program called Doctor T. [...] I built a MIDI interface for the Commodore, I built it myself because you couldn't buy those in (XXX) at that point. You could only get them from here [USA], but I didn't have any contacts. It was actually cheaper for me to build one than try to get one" (33:*A230).

Appendix E

Naumann and Wagoner's Sixteen Compositional Projects

Based on Naumann and Wagoner, Chapter 16 "Composition Projects", (Naumann and Wagoner, pp. 413-416).

1: musique concrète (collage) tape piece
2: tape manipulation of acoustic sources with electronic processing effects
3: tape piece based on an electronic signal source
4: tape piece based on multiple electronic signal sources with studio editing and effects
5: tap piece using both collage and electronic sources
6: electroacoustic tape soundtrack for a non-live artistic medium (film, etc.)
7: live performance of the solo analog synthesizer
8: live performance in which tracking of live sounds triggers the analog synthesizer
9: live improvisation with voltage-controlled devices
10: live tape manipulation
11: studio-processed pre-recorded acoustic performance
12: live performer with a pre-recorded tape
13: phase/spatial experimentation with tape
14: tape piece for dance performance
15: tape piece for a multimedia performance
16: interactive installation using either pre-recorded material or live sound analog processing

Appendix F

Eight Cases of the Change of Compositional Interest

#1 Pre-MIDI: designing composer / computer interface -> MIDI: live interaction

> "It's not as much of a shift as a growing awareness of something. In some sense, the work that I'm doing now is trying to recapture some other things I have lost. I don't think I explicitly recognized how much I enjoyed directly interacting with another person to produce this collaborative sound" (1:*A580). "With MIDI, being more interactive, [being able to] recapture some sense of spontaneity, improvisation as opposed to the focus on evolving structures, sound objects. [...] When I think of MIDI I think in terms of live, interactive type of things. Even in the studio I still think of MIDI as something to use to lay down what you perform live whereas with the software synthesis that's not part of it at all. I see those trends merging now" (1:*B15).

#31 Pre-MIDI: timbre -> MIDI: live interaction, improvisation

> "I think MIDI was great because it created a common protocol for communication. [How did that shift the focus?] - It got me back into the performing, I'm more interested in the performance issues and what I could do with the live performance. Before that my thinking was more along the lines of tape pieces, non-real-time issues, a little more pre-mediated composition. The ability to make use of this common interactive protocol led me in a different direction, in the direction of thinking of live performance issues and real-time interaction" (31:*A360). "Improvisation. If you think of improvisation being spontaneous composition then I'm more interested in that [since introduction of MIDI" (31:*B60).

#34 Pre-MIDI: algorithmic composition -> MIDI: live interaction

#40 Pre-MIDI: extension of timbre -> MIDI: live interaction

#24 Pre-MIDI: timbre -> MIDI: interactive (synthesizer / computer) improvisation

In the only piece written for MIDI, the composer observes a change of focus:

> "Yes. I really wanted in that piece and I think I succeeded to develop the kind of an improvisatory connection with some algorithm. I really liked the idea of an algorithm as a generator of a musical shape. I think the piece succeeded more when it was improvising its own alphabet" (24:*A475).

#32 **Pre-MIDI: timbre -> MIDI: control and interaction**

"I have to admit that my interest shifted to control from the timbre" (32:*B88). "MIDI made it possible for me to do these interactive pieces. [...] It's a change in my focus - when I do a MIDI piece I may be content to more or less use the sounds that are in the synthesizer with a few tweaks whereas when I'm doing a piece in software synthesis or real-time synthesis [..or], some other medium, like Music Kit which combines both, I might be more concerned with the details of the sound than I would be in a MIDI piece. In a MIDI piece I am more concerned with the pitch structures. I wouldn't say it's somehow revolutionized my thinking, it's more like [that] the pieces I write for this medium have more of these characteristics, a concern with interaction for one thing. An interaction has a lot of interesting aspects such as the ones I was talking about: permeability between instruments, new concepts of form that are kind of improvised, autonomous processes in the computer that you interact with -- those follow from having interactive computers" (32:*A330).

#7 **Pre-MIDI: timbre -> MIDI: pitch / time relationships**

"In "XXX" {the only MIDI piece} it's not about timbre, it's about pitch/time relationships, and you interact at a high level with some algorithms that then generate these pitch/time relationships. That's very much similar to what I did in some tape pieces before. [...] The timbre is so simple is that you just listen to the notes rather than listening to the texture. Before I had done MIDI, [I did] very rich sound pieces, timbre pieces and then I switched to a lot of pieces where timbre was not in the control structure at all. [For example] I did a couple of tape pieces using just MUSIC 11 with very simple FM bells but very fancy expert systems who generate the notelists and that's what I did in "XXX" also, I said I'm going to have simple *note-on, note-off*, not going to control those with pitchbend or anything. [Was that easy to do with MIDI?] -Yes, there wasn't a microtonal standard [in MIDI]. The tape pieces thatI did before "XXX" were very densely microtonal. In "XXX" I had to obviously go well-tempered" (7:*A570).

#6 **Pre-MIDI: timbre -> MIDI: events and their characteristics**

"What I think is perceptionally important in the way we're hearing music is the gestalt of what we hear. If you had a large enough analog system and one that was flexible, like Buchla 200, you could really free yourself from 'event-based thinking' and compose in terms of gestalt. [...] There was a kind of freedom and adventureness in working with event-controlled voltage systems that if you work with MIDI in terms of using computer [...] there was a big difference. The result was that pieces, including my pieces, became much more event-oriented than they had been before. [...] much more pitch-oriented than timbre-oriented. One of the things that now is very easy to do with computers which is to take sound A and sound B and interpolate between them is something I worked very hard on in terms of the analog being able to do what I call 'linear-timbral transformations' from one thing to another which other people weren't working with. And that had to be accomplished real-time. Those kinds of things sort of went out the window when I started dealing with MIDI. You are more concerned about working in the event-lists, stating all the specific information for each event and worrying to get an external hard to sound relatively decent instead of the factory sounds that everybody else was using" (6:*A323).

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Products of interest. -- IVL Pitchrider products; Linn 32-track MIDI sequencer; Prophet 2000 digital sampling keyboard; Cherry Lane Technology software; Fairlight Voicetracker; Deluxe Music Construction Set for the Macintosh; Octave-Plateau MIDI interface for IBM PC; DX/TX for IBM PC; MIDI Ensemble for IBM PC; Armonyx digital synthesizer for IBM PC. *Computer Music Journal*, 10(1), pp. 106-115, Cambridge, Mass.: MIT Press, 1986.

Products of interest. -- Promidi software; Prophet VD digital synthesizer; Prophet 2002 Rackmount digital sampling synthesizer; Roland digital piano sound module; Sound Designer 2000; Korg DVP-1 Digital Voice Processor; Korg SG-1 Sampling Grand; Mirage digital multi-sampler; Korg DSS-1 sampling synthesizer and updates; Personal Composer version 2.0; Tecmar music synthesizer for IBM PC; Casio digital synthesizers; Syntech keyboard controller for Commodore 64. *Computer Music Journal*, 10(2), pp. 87-93, Cambridge, Mass.: MIT Press, 1986.

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The music machines. Hosted by Jim Hartz. WNET-TV, New York, NY, Princeton, N. J.: Films for the Humanities & Sciences, 1993.

5. Internet Information Resources[133]

5.1 Newsgroups and Bulletin Boards

alt.binaries.sounds.midi

alt.music.midi

The WELL's MIDI Conference. Electronic bulletin board system. To access: dial (415) 332-6106, type "newuser" at the login prompt. type "go midi".

5.2 World Wide Web MIDI-related Information Sites

Computer Music Journal WWW/FTP Archives. http://mitpress.mit.edu/pub/Computer-Music-Journal/CMJ.html

The MIDI Farm. http://www.midifarm.com/

MIDILink Musician's Net. http://www.interaccess.com/users/midilink/

MIDI Home Page. http://www.eeb.ele.tue.nl/midi/

MIDI Tools and Resources. http://harmony-central.mit.edu/map.html

MIDIWeb. http://www.eeb.ele.tue.nl/midi/midiweb/

[133] These are the main sources for information, containing multiple links to other MIDI-related resources on the Internet as of August 1996.