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Electro-Acoustic Music: An Historical Overview, with an In-Depth Study of Preparatory Techniques for Mario Davidovsky's Synchronisms No.9 for Violin and Tape

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Electro-Acoustic Music: An Historical Overview, with an In-Depth Study of Preparatory Techniques for Mario Davidovsky's Synchronisms No.9 for Violin and Tape

By

Andrew Rafael Perea, B.M., M.M.

Treatise

Presented to the Faculty of the Graduate School of the

University of Texas at Austin

In Partial Fulfillment

Of the Requirements

For the Degree of

Doctor of Musical Arts

The University of Texas at Austin

August, 1998

Preface

It is with great optimism that I present this resource of modern-day American music. The time appears right for the importation of *electro-acoustic music* as a major compositional force in the United States. After many years without a bona fide musical identity, it seems that the U.S. now has access to a medium, capable of making a formidable contribution to the world of classical music. The almost unlimited amount of compositional resources makes electro-acoustic music a perfect choice for individual expression, as well as structural consistency.

In fact, an electro-acoustic performance may come to represent an event which transcends the scope of a mere compact disc recording, for example. This is due to vast possibilities of incorporating other mediums, such as dance, video, or computer animation. These kinds of visual stimuli seem to go hand-in-hand with

the abstract nature of electro-acoustic music. The successful merger of contrasting mediums ensures the uniqueness and *freshness* of each individual electro-acoustic performance.

An excellent representation of electro-acoustic music is ***Synchronisms No.9***, for violin and tape, composed by **Mario Davidovsky**. This work for live performer and electronics exemplifies a mastery of the fusion of two contrasting sound mediums into a single, multi-faceted genre of music. The *merging* process, as well, involves many challenges for the violinist, including tonal, metrical, and timbral synchronization, as the title suggests. Thus, the complex structure of *Synchronisms No.9* makes it an effective vehicle for the exploration of violin technique, serving as a model of comparison between modern and traditional styles of writing. Upon examining these technical and mechanical relationships, the performer of the violin is able to formulate more *informative* overall strategies of preparation.

Such reasons have led me to produce this treatise aimed at teachers and students of the violin, encouraging the performance of electro-acoustic music. I sincerely hope that this current, worthwhile genre is capable of making a legitimate contribution to the field of classical music. Innovative developments, such as electro-acoustic composition, are key to the continued growth of practical musical careers in the United States.

Electro-Acoustic Music: An Historical Overview, with an In-Depth Study of Preparatory Techniques for Mario Davidovsky's Synchronisms No.9 for Violin and Tape

Publication No. _____

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The University of Texas at Austin, 1998

Co-supervisors: Patrick McCreless
Eugene Gratovich

The basis of this treatise is to present violin professors and performers with a resource, designed to encourage the study and performance of electro-acoustic music. Thus, this document intends to clarify the implications of the term *electro-acoustic music*, as well as explore its history and development, both from

a technological and compositional standpoint. The inclusion of a somewhat extensive overview serves to show the credibility of electro-acoustic music as a vastly explored and developed genre, which, up until now, may not have been recognized as such. Most importantly, however, this treatise contains a substantial study of techniques used in the preparation of *Synchronisms No.9* for violin and tape, composed by Mario Davidovsky. The significance of this study is twofold. Firstly, it serves to familiarize the present-day violinist with current trends of electro-acoustic composition. Secondly, *Synchronisms No.9* provides a thorough curriculum of training for violinists, encompassing almost the entire spectrum of violin technique, as well as addressing other important musical issues. My ultimate aim is to utilize the genre of electro-acoustic music as a vehicle for the promotion of modern American composition and performance, thus, contributing to the growth of musical careers in the United States.

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Chapter 1

An Historical Overview of Electro-Acoustic Music

Definitions and Terminology

Basic Distinctions

"The world of electro-acoustic music is larger than many people imagine."[1] In fact, the term *electro-acoustic music* has many connotations. Barry Schrader states that it "... refers to any music that is produced, changed, or reproduced by electronic means."[2] This broad definition can be broken down into various subtopics for a clearer overall understanding of what is termed electro-acoustic music. Though each of these

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[1] Barry Schrader, Introduction to Electro-Acoustic Music (Englewood Cliffs, N.J.: Prentice-Hall, 1982), p. 1.

[2] Ibid., p. 1.

areas reflect the use of electronics, they are not necessarily tied to one another as closely as one would think.

Compositionally speaking, there are two ways of using electronics to generate sound materials for musical use. The first way involves the recording or reproduction of actual sounds found in the natural, acoustic world. These sounds, known today as *samples*, serve as the basis for possible electronic enhancements and manipulations made by the composer. The resulting material is then reworked and edited, ultimately comprising the finished product. This style of composition stems from the tradition of ***musique concrète***, which will be discussed later on in this chapter.

The other way to initiate the composition of electro-acoustic music is to generate the fundamental sounds using purely electronic means. Thus, ***electronic music***, as it is aptly named, uses electronics as the core material, as well as a sound processing tool. The present trend of electro-acoustic composition

encourages the merging of both processes into a single work. This is mainly due to the substantial growth and development of ***personal computers*** or ***PCs***, enabling the composer to utilize multiple forms of electronic media very efficiently.

MIDI Sequencing

In conjunction with composition using personal computers, there exists an international standard for digitally encoding music performance data, which includes the possibility of using both sampled and electronically-generated sounds. ***MIDI***, or *Musical Instrument Digital Interface*, is a medium comprised of special computer hardware, appropriate software, and an optional choice of electronic instruments that can link up with the computer. Essentially, MIDI is a communications specification by which compatible devices are able to relay data back and forth, thus, coordinating the execution of a piece of music. The music is entered into a computer via a ***sequencer*** or

sequencing program, which is typically designed to reflect the notational conventions of traditional Western music. In turn, the sequencer translates the visual representation of the music into MIDI format, and directs the output of the linked MIDI hardware devices, accordingly. The actual sound of each device is made audible by electronic amplification, either built into each individual unit, or *mixed*, collectively, through a common system. Thus, in actuality, a MIDI performance is greatly dependent upon the capabilities of the hardware and the software for its success. In fact, there is an extremely wide selection of hardware, from devices generating electronically-simulated acoustic sounds to those producing intricate reproductions of acoustic instruments, sampled one note at a time. While this particular idea may be viewed by some as a crutch, there are other features of MIDI that can be very effective, especially in the preparation of electro-acoustic music. These features will be discussed in the next chapter.

Presentation and Performance

The term electro-acoustic music may also refer to the various ways in which the music itself is presented or performed. *Tape music* applies to any work that is comprised of pre-recorded (taped) sounds, whether acoustic, electronic, or a mixture. Although Schrader, at the time of his publication, was actually referring to reel-to-reel or cassette tape, the modern use of *digital audio tape*, or ***DAT***, is merely an improvement in technology; the concept of tape music is still the same. Thus, a *studio composition* represents a work which is fully realized onto tape, personally, by the composer. In other words, the piece itself is completed and heard in the studio and does not necessitate the use of live performers to perform a score or manuscript. In fact, there is usually no score to a studio composition, since it is unnecessary.

If a composer decides to incorporate the use of a live performer or performers along with tape, however, the label of studio composition changes to that of ***live/electronic music***. This particular subheading of

electro-acoustic music has other significations, as well. Live/electronic music may also refer to that which is termed *real-time performance*, as well as the combination of live performer(s) with real-time performance. The unique feature of real-time performance is that the sound being produced is generated during the performance, whether by computer or synthesizer, in contrast to being pre-recorded onto tape. Nonetheless, this may involve some sort of pre-programming, such as the creation of synthesis algorithms, pre-composed sequences, or interactive control software. A more complex form of real-time performance incorporates the use of one or more live performers. In this case, there exists the possibility of real-time interaction between the performer and the electronic medium. A microphone or *pickup* may be used to input the musical data of the performer to an electronic device, which, in turn, processes the information in a manner specified by the composer. The resulting material may then be utilized in various ways at a future point in the same performance.

Historical Overview

All of the previous information represents a rudimentary understanding of electro-acoustic music. It is also necessary, however, to explore its roots and developments, in order to fully recognize and appreciate electro-acoustic music as a valid form of modern composition. There are two main categories to examine in this area. The first is the evolution of electronic instruments, such as synthesizers, and related technology. The second focuses on the development of compositional technique, including composers and their exploration of new timbres and technological approaches.

Technological Developments

Telharmonium

The turn of the twentieth century marked the starting point for the use of electronic devices for

musical purposes. The invention of the ***Telharmonium*** or

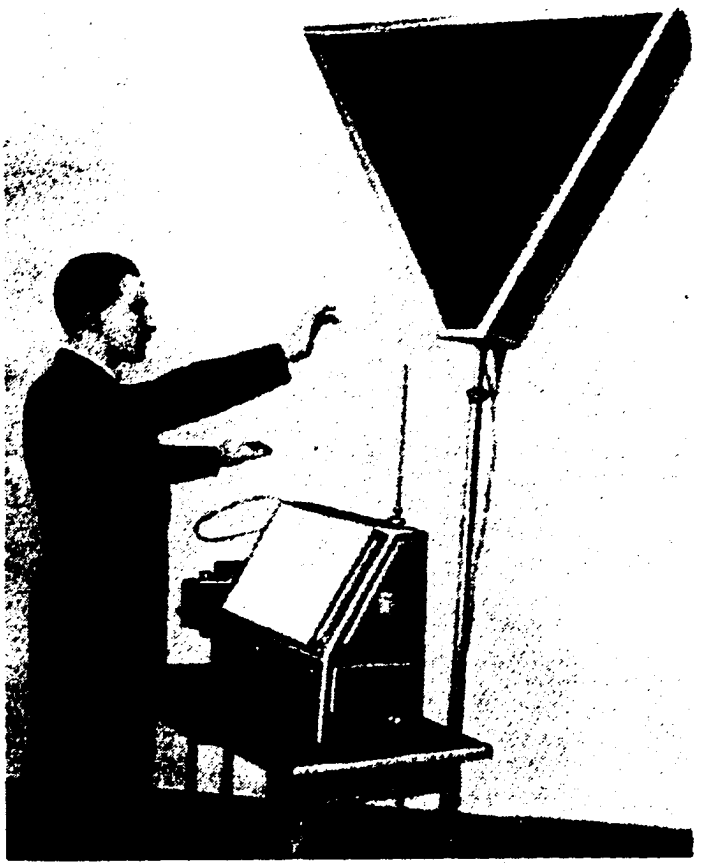
Telharmonium

Dynamophone by **Thaddeus Cahill**, originally demonstrated to the public in 1906, represented a *sizeable* contribution to the world of electronic music. This huge 200 ton, 60 foot high assemblage of dynamos, employing large geared shafts, is one of the first notable musical instruments that produced sound by the manipulation of electric current. An important detail

to point out is that the Telharmonium featured a piano-style keyboard as the control device over the instrument. In contrast to that of an acoustic piano, the keyboard on an electronic device is not a critical design component. Whereas the mechanical action of the keys on a piano are crucial to its sound production, the ones on a synthesizer, for example, are purely for purpose of triggering events. In fact, Cahill could have used buttons or devices similar to telegraph switches to control the sound. Thus, the Telharmonium may have set the example for future synthesizer designs, since its use of a keyboard for controlling parameters, such as pitch, is standard on most modern synthesizers today.

Thérémin

Around 1920, there emerged a unique electronic instrument, which contrasted much in design to that of Cahill's Telharmonium. The ***Thérémin***, created by and named after Russian scientist Lev (Leon) Thérémin, had an original way of manipulating electronic pitches.



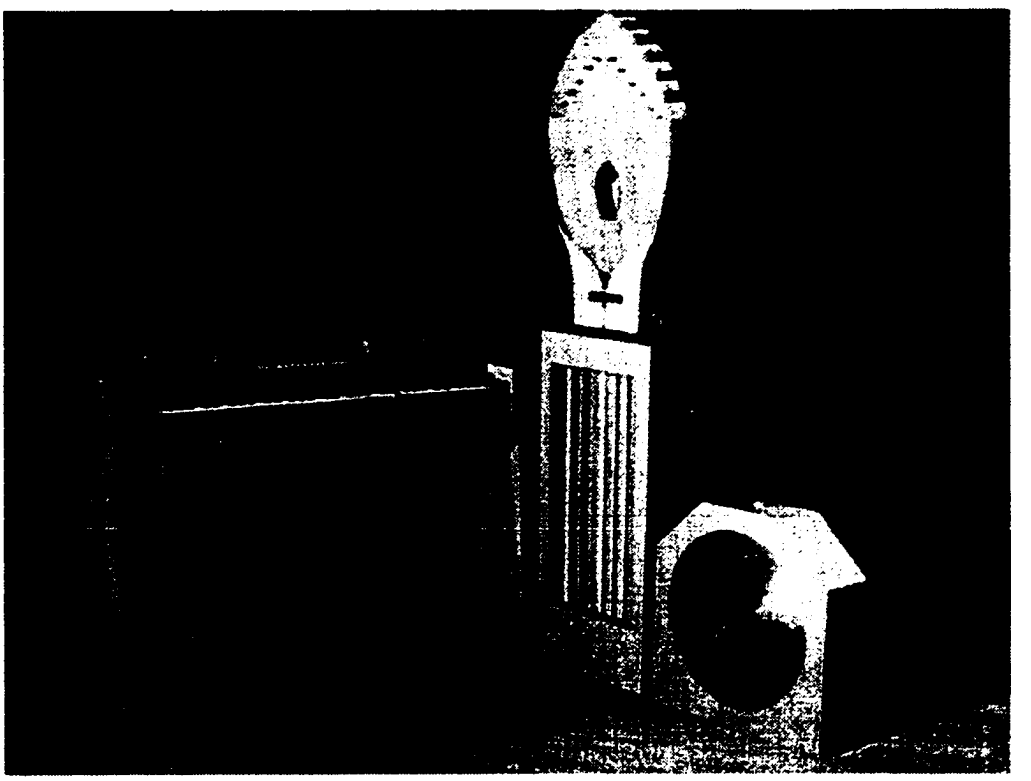
Thérémin

The instrument consisted of two antenna-like rods, one straight and one curved. The performer manipulated his or her hands around each rod, thus altering the pitch and amplitude, respectively. The eerie sound quality of the Thérémin made it a popular choice for 1950s

science fiction films, including *Forbidden Planet*. In the following decade the pop music group, *The Beach Boys*, immortalized the Thérémin in their hit song ***Good Vibrations***.

Ondes Martenot

In 1928, a further move towards the modern design



Ondes Martenot

of electronic instruments was represented by the ***Ondes Martenot***. Maurice Martenot produced an instrument using a basic keyboard design, as well as other controllers, which could produce different special effects. For example, a sliding ribbon was used to produce a sliding of pitch, thus creating an electronic glissando effect. This capability is a standard feature on most synthesizers today, executed typically by a device known as the pitch modulation wheel. Whereas the Thérémin had more of a commercial appeal, the Ondes Martenot seemed to attract the attention of innovative classical music composers, such as Arthur Honegger, and Olivier Messiaen. In fact, Messiaen incorporated its unique quality into his noted ***Turangalîla Symphony***.

Givelet

The ***Givelet***, a forerunner of the *Hammond* organ, was introduced in 1929. Designed as a replacement for the pipe organ, it was one of the first electronic instruments that could produce multiple pitches (i.e.,

Givelet

chords) at the same time. Most similar devices prior to the Givelet, such as the Ondes Martenot, were monophonic, used solely in linear, melodic fashions. The main contribution of the Givelet is that it incorporated the use of pre-punched tapes, similar to the idea of a player piano:

> "This ability to program the production of sound foreshadowed devices, such as the RCA

> synthesizers, and more generally, the use of computers in sound production a quarter of a century or more later."[3].

Although this particular type of construction was to become extremely popular and marketable in the field of pop music, as an alternative to the piano, it was arguably of value to the composer of classical music, as will be discussed later. This is mainly due to creative limitations attributed to these types of electronic keyboard-type instruments, which served solely to reproduce or expand features of an acoustic piano or pipe organ.

Magnetophon (Magnetic Tape)

The invention of the ***Magnetophon*** in 1935 was a significant development for musical composition. This was the first device which incorporated the use of magnetic tape in its modern form. Consequently,

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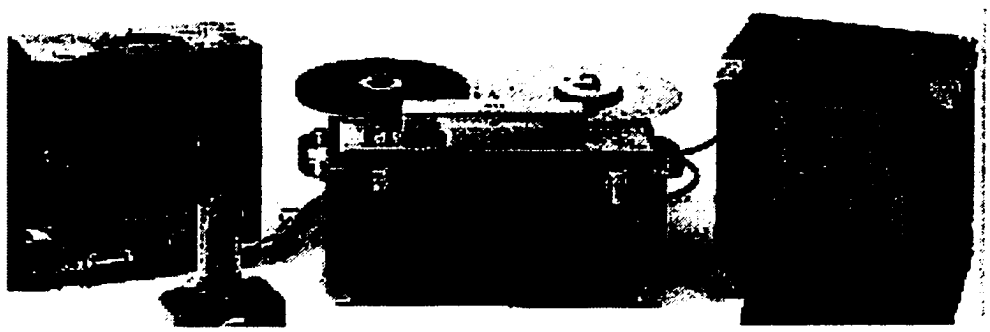
[3] Peter Manning, Electronic and Computer Music (Oxford: Clarendon Press, 1985), p. 3.

magnetic tape played an important role in the development of musique concrète and electronic music:

> "The primary advantages of the new medium were the facility to re-use the recording tape, the ease of editing, and the ability to record two or more discrete tracks of recorded information, simultaneously, on the same piece of tape."[4]



Magnetophon

The one drawback for the composer, however, was the lack of a visual representation or score, which was crucial to composition prior to this time.

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[4]Manning, op. cit., p. 13.

Vocoder

The problem concerning the lack of a visual aid was addressed in 1948. **Homer Dudley** of Bell Telephone Laboratories developed the ***Vocoder*** or ***Voder***, as it was commonly called, which had the capability of analyzing

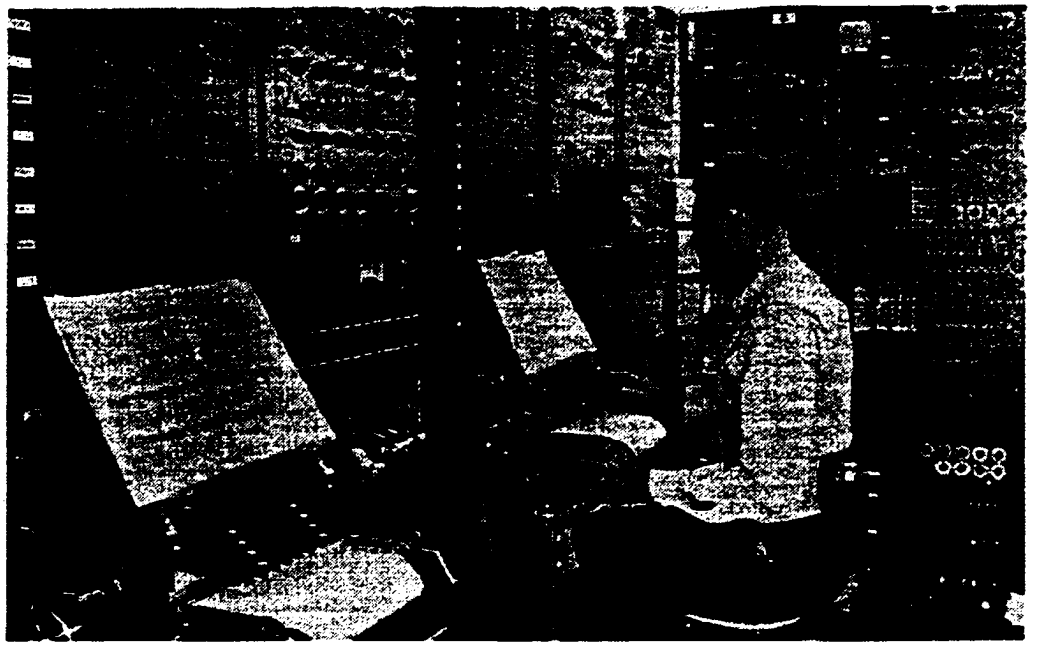
Vocoder

speech, graphically, as well as reproducing speech, artificially. Although it was not designed for the analysis of music, the Vocoder proved very effective in breaking down the voice into manipulable parameters, such as frequency and timbre. This was achieved by the use of a number of filters, spanning the entire sound spectrum. Each filter recognized only the sound data falling within its frequency range. Thus, the Vocoder could not only display an accurate visual representation of sound, but could also synthetically reconstruct speech patterns, conversely, by scanning graphs formatted for the Vocoder. Whereas frequency was expressed vertically, from lows to highs, timbre was shown by various shadings.

RCA Synthesizer

The idea of manipulating sound with filters and other modulatory devices was important to companies besides Bell Telephone. Throughout the 1940s the *Radio Corporation of America,* known as **RCA,** explored the development of communications and acoustics-related

devices. Its exploration of the intricate manipulation of sound waveforms culminated in 1956 with the ***RCA Synthesizer.*** The original version, called the Mark 1,



RCA Synthesizer

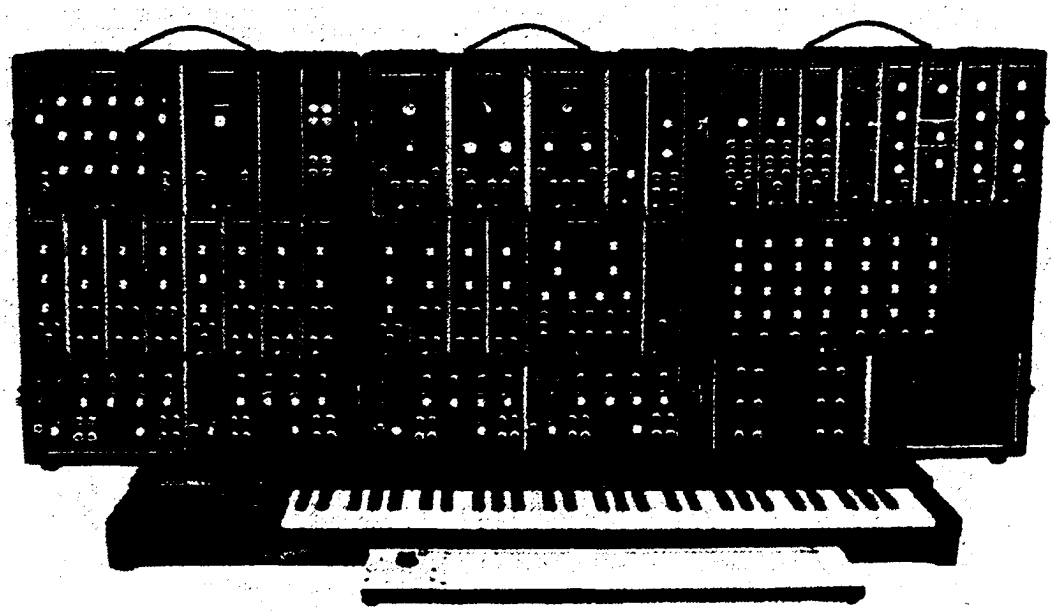
was a major contribution to the processing of electronic sound. It featured two separate but integrated channels, each able to generate and modify sound using components such as controllers, filters, modulators, and oscillators. Although the capabilities

of the Mark 1 and, later, the Mark 2, were impressive they still had their limitations. The most obvious were cost and size. The universities of Columbia and Princeton were the exclusive buyers of the RCA synthesizer, paying around $175,000 in a joint effort to construct the Columbia-Princeton Electronic Music Center. Besides the high cost, the synthesizer was nowhere near portable, filling up the majority of space in the studio.

Voltage-Controlled Synthesizers

A few years later, the effective manufacturing of the *transistor,* replacing the inferior, bulkier construction of vacuum tubes, led to a monumental development in the design of the synthesizer. In 1964 **Robert Moog** constructed the first ***voltage-controlled*** musical device utilizing transistor technology. Basically, this new technology could achieve similar results to the RCA Synthesizer, without the high cost and impractical size. Soon, other companies besides Moog began recognizing and exploiting the marketability

of voltage-control, including **Buchla**, **Tonus (ARP)**, and **EMS Limited**.



Moog Synthesizer (one of various models)

In short, these four companies set the design standard for today's synthesizers. Such standard features included portably-sized modules fitted with controllers, such as keyboards, used to regulate frequency or pitch, and intensity or volume. As well,

there were a number of sound oscillators and modulators in the form of knobs, dials, and joysticks.

Unfortunately for the composer on the forefront of technology, the choice of a piano-style keyboard as a means of controlling the generation of electronic sounds tended to be a limitation to compositional creativity, as mentioned earlier. One probable reason that companies, such as Moog, incorporated a keyboard controller was its universal appeal to most people, including non-musicians. Whereas initial intentions may have been that of research and development, the discovery of a marketable product seemed to inhibit further substantial innovations in the design of electronic instruments. Thus, composers of electronic music outside of the major studios were somewhat limited to the confines of traditional keyboard-based composition. Although certain composers contended that the Buchla synthesizer "...freed the compositional mentality from 'keyboard' thinking"[5], because it used a

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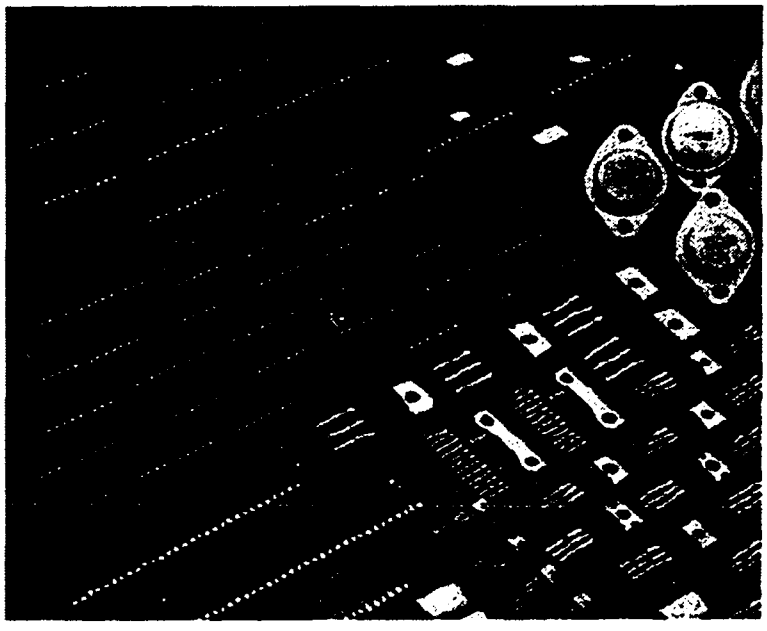
[5] Elliott Schwartz, Electronic Music - A Listener's Guide (New York, N.Y.: Praeger Publishers, 1975), p. 76.

series of touch-sensitive plates instead of an actual keyboard, its arrangement of plates were horizontal, similar to that of keyboard synthesizers. Inevitably, the Buchla construction yielded to that of the Moog after the 1960s. In general, there were no other substantial contributions to the design of electronic instruments during this time.



assorted integrated circuitry

Semi-Conductor Integrated Circuits

"The 1970s have marked another revolution in electronic circuitry."[6] Following the development of the transistor came another invention of major importance, namely, ***semi-conductor integrated circuits.*** This technology was crucial to the radical growth of computer technology, which was in its infant stages. Similar to the evolution of the synthesizer, the computer went from costly and large to a marketable size. This is mainly because integrated circuit boards could "...contain more than 100,000 transistors etched on a silicon chip the size of a thumbtack head."[7] Obviously, this drastic increase of both capability and compactness was instrumental to the widespread development of computers for personal, as well as for commercial use.

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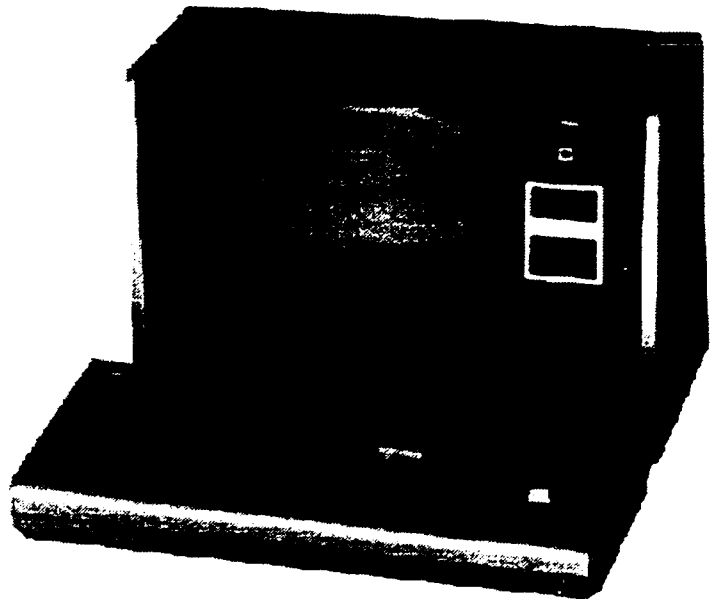
[6] Wayne Bateman, Introduction to Computer Music (New York, N.Y.: John Wiley & Sons, 1980), p. 5.

[7] Ibid., p. 5.



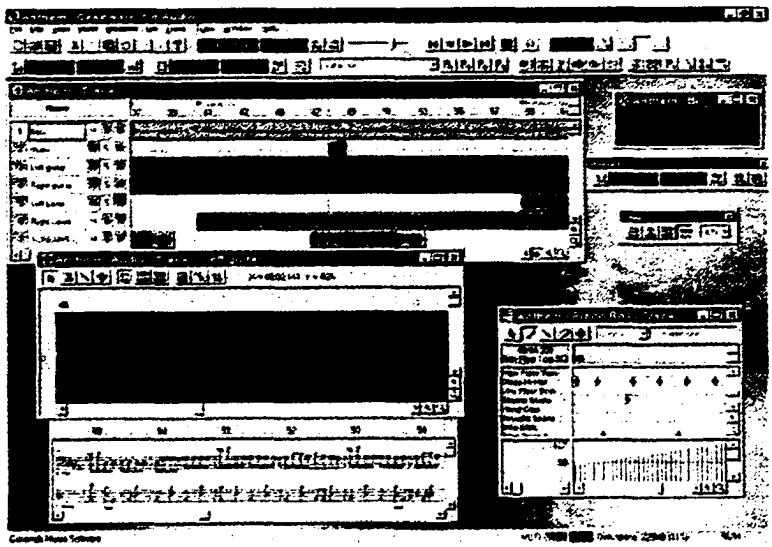
TRS-80 (early model PC)

Personal Computer

By the end of the 1980s the personal computer industry enjoyed a remarkable growth. This was due to major advancements in processing capabilities, along with a reduction of cost. Consequently, this lead to a larger public demand. The success of computers may have been the result of their effective application to most every field of study, including mathematics, science, art, and music. This universal design allowed

PCs to process a large amount of a variety data types reasonably quickly, depending on the complexity of the material. Such processing capabilities included controlling, organizing, arranging, formatting, restructuring, and interpolating or generating new data. The data, in turn, could be outputted in various ways, such as video, audio, and hard copy.

In the field of music, computers expanded the possibilities of both electronic and traditional composition, and also aided in transcribing and arranging. The PC began being used for sequencing, sampling, sound generating, sound editing, and music notating. In short, computers were programmed to implement the large number of sound processing calculations that were originally done manually with synthesizers, such as the RCA Mark 1. Thus, the composer of electronic music was able to focus more on creativity rather than computations.



Cakewalk ProAudio (sample screen view)

Software

Today, vast improvements have been made to the processing power of computers. At present, the capabilities of computers and computer-related devices are advancing at an extremely rapid rate. As a result, effective new software programs, which are easier to use and much more intensive in scope, allow most every composer of electro-acoustic music to have access to state-of-the-art facilities. Many of these programs specialize in different areas of composition, or cater

to different approaches. Such programs include ***Pro Tools***, ***Sound Forge***, ***Alchemy***, ***Sound Designer***, and ***SoundHack***, for recording, editing, and processing sound, ***C-Sound***, for generating electronic sounds, and ***Studio Vision***, ***Digital Performer*** and ***Cakewalk ProAudio***, among others, for integrating digital audio with MIDI sequencing.

Compositional Developments

Italy: Futurism

As mentioned earlier, it is also important to examine the roots of electronic composition, including the various composers who experimented with, and promoted the development of modern sounds and sonorities. Beginning around 1909, there began a cultural movement in Italy which was influenced by "...the age of the machine, motion, war, and violence."[8]

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[8] Elliott Antokoletz, Twentieth-Century Music (Englewood Cliffs, N.J., 1992), p. 341.

Futurism, as it was called, advocated the exploration of modern age sounds, such as those produced by various machinery, as the basis for works of literature, art, and music. The person directly associated with the birth of Futurism was **Filippo Marinetti**, who used the term in an article found in a major periodical. His onomatopoeic use of the voice in a war poem, depicting *machine guns*, inspired musician **Franceso Pratella** to consider the possibilities of replacing pitch with *noise*. Pratella, in turn, influenced composer and painter, **Luigi Russolo**, who "... in 1913, presented his theories in a more radical musical manifesto, L'arte dei rumori (The art of noises)."[9]

Probably the most important role of the Futurists was their influence on prominent composers, including Maurice Ravel, Igor Stravinsky, and Edgar Varèse. These composers were in attendance at concerts in Paris

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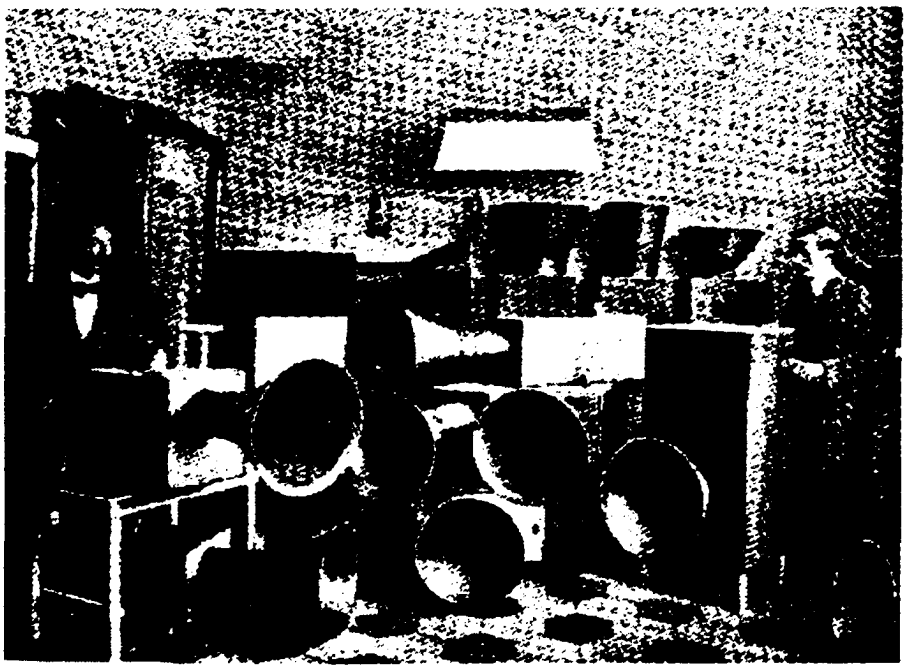
[9] **Antokoletz, op. cit., p. 341.**

featuring Russolo's *Futurist Orchestra* in 1921. Russolo helped create devices known as *intonarumori*



intonarumori

(noise intoners), specifically designed for this orchestra, made from a combination of various electrical and acoustical parts. Though each of the three reputable composers were intrigued by the display of innovative sound techniques, only Varèse eventually explored the avenue of electronically-generated sound.

Déserts (1954) and ***Poème électronique*** (1958) were Varèse's two major works incorporating the electronic medium.

France: Musique Concrète

Some twenty seven years after the performances of the Futurist Orchestra, there began a movement in Paris which directly shaped the future of electro-acoustic music. ***Musique concrète*** emerged in 1948, when **Pierre Schaeffer** produced his first significant work utilizing the manipulation of recorded acoustical sounds. ***Études aux chemins de fer*** exploited the use of an early record player, known as a gramophone, which could mechanically transform sounds, such as steam engines, in this case. Of course, the gramophone used by Schaeffer in the studio of the French National Radio was somewhat limiting. His only effective means of altering recordings were by playing them backwards or changing speeds. Despite this handicap, Schaeffer, along with collaborator **Pierre Henry**, produced a work of substantial merit in 1949, entitled, ***Symphonie pour un***

homme seul, which featured the use of many gramophones and loudspeakers.

It was not until the incorporation of *magnetic tape* in 1950, mentioned earlier, that musique concrète made real, creative progress. In fact, it was not until this time that Pierre Schaeffer actually began using the term musique concrète in reference to his unique form of musical composition. ***Bidule en ut,*** written by Henry in 1950, represents a clear example of the concrète compositional process. Unrestricted by the limitations of the gramophone disk, magnetic tape offered Henry a wider spectrum of capabilities. This was mainly due to the fact that tape could also be physically edited, such as cutting and reattaching, etc. Thus, many other possibilities existed apart from the basic sound reversal and speed modifications offered by the gramophone. Such ideas included:

> "...greater control and extension of dynamic range, ostinato patterns produced by the use of tape loops, multiple tapes employed in overlap, isolation of the core of a given sound or noise by elimination of its attack

and/or decay, use of echo chambers, and other techniques."[10]

West Germany: Cologne Studio

In contrast to Henry and Schaeffer's strict application of musique concrète, which dealt with the recording of acoustic sounds to tape, **Dr. Herbert Eimert**, at a studio in Cologne, West Germany, was experimenting with taping sounds generated electronically. Eimert's composition ***Four Pieces*** (1952-1953) is one of the first examples of pure electronic music. This work certainly reflects the early stages of electronic composition in that it evolves out of the most basic electronic element, the *sine tone*, which is devoid of any overtones.

Apart from the initial distinction between the mediums used in Paris and West Germany, later composers tended to fuse both compositional processes into their works. **Karlheinz Stockhausen**, who ultimately became

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[10] Antokoletz, op. cit., p. 450.

the director of the Cologne studio in 1963, finished ***Gesang der Jünglinge*** in 1956, a work exemplifying an effective fusion of styles. Stockhausen's fundamental structural material is that of a boy singing from the book of Daniel, in the German language. He craftily transforms the voice by either manipulating its own properties or infusing electronic sounds into the texture. The work unfolds as a result of this convincing interplay, generated from the consonant and vowel sounds of the text. The result is a haunting sonority depicting the natural versus the supernatural.

United States: Columbia-Princeton

In 1961, the first of many electro-acoustic concerts were given at Columbia University in the United States. These were directly related to the deployment of the RCA Synthesizer at the Columbia-Princeton studio, as mentioned earlier. The works represented offerings of various well-known composers, including **Milton Babbitt, Otto Luening, Vladimir Ussachevsky,** and **Mario Davidovsky.** ***Gargoyles,*** written

by Luening, was an early example of synthesized sounds combined with a live violin performer. The main criticism of the work was that it lacked "...a satisfactory continuum between two sharply contrasting sources of sound material."[11] Whereas *Gargoyles* and most of the other works reflected a more traditional *acoustic* approach to composition, ***Electronic Study No.I*** composed by Davidovsky made "...the deepest excursion into the subtleties of textural manipulation, in a manner reminiscent of that adopted by the Milan school of electronic music."[12]

West Coast: Morton Subotnik

Five years after the inaugural performances at Columbia, the innovative composer, **Morton Subotnik**, was beginning to achieve notoriety in San Francisco for his contribution to electro-acoustic music. Whereas the composers at Columbia were certainly utilizing the

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[11] Manning, op. cit., p. 113.

[12] Manning, op. cit., p. 114.

capabilities of the RCA Synthesizer, Subotnik was one of the most important advocates of the voltage-controlled *Buchla* Synthesizer. As mentioned earlier, the Buchla did not offer an organ-like keyboard, as did its *Moog* counterpart. This made it more desirable as an instrument of studio composition, rather than that of performance.

Silver Apples of the Moon (1967) was one of Subotnik's first commercially successful pieces of electronic music. As well as incorporating some of the more conventional waveforms and modulations, the composer explored the vast timbral capabilities of the Buchla Synthesizer:

> The most striking material in this piece is the first section of Part II. This is a real-time realization, showing the power of Buchla's new system. This dance-like music with its ostinatos and layered rhythms, punctuated by random bursts, became typical of Subotnik's early electronic music and is one of its most imitated features.[13]

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[13] Schrader, op. cit., p. 131.

This association between Subotnik and the Buchla Synthesizer was a prolific one, yielding many innovative works, such as ***The Wild Bull*** (1968) and ***Touch*** (1969). In short, Subotnik's main contributions to electro-acoustic music centered around rhythm and metric repetition, and the structural and functional exploration of timbre.

Computer Music: Charles Dodge

In 1970, the formidable potential of computer technology was demonstrated at Princeton. The Princeton studio, established in 1964, exemplified the effectiveness of using the computer for electronic composition:

> There is no question that the computer allows composers the best method of realizing complicated procedures and translating involved processes into sound. An extreme example is offered by *Earth's Magnetic Field* (1970) by Charles Dodge.[14]

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[14] Schrader, op. cit., p. 156.

Charles Dodge composed ***Earth's Magnetic Field*** by translating information from a non-musical medium, called a Bartels diagram, into usable musical data. The Bartels medium was normally used to represent various changes in the magnetic activity of the Earth. However, the graphic notation of the this diagram reflected similar characteristics to that of musical notation. The main resemblances were *time* projected horizontally, and *degree* projected vertically. Thus, Dodge was able to construct a compositional system based on these correlations.

The work is divided into two sections, the first implying a sense of diatonicism, while the second appears to be more chromatically oriented. There is also a contrast between monophony and polyphony, respectively. Although Dodge is certainly using a much different approach to the realization of this work, as compared to Morton Subotnik's *Silver Apples of the Moon*, he seems to be concerned with the same issues. The exploration of timbre pervades the first part of *Earth's Magnetic Field*, while rhythmic complexity

dominates part two. The mutual attention given to these specific areas, by composers utilizing different electronic methods and mediums, may suggest that there exists an underlying sense of cohesion which is inherent to the compositional makeup of electro-acoustic music.

Mario Davidovsky: *Synchronisms*

Mario Davidovsky's prowess at textural manipulation, as mentioned earlier, brought much success and acclaim to a series of works for tape and performer(s) known as ***Synchronisms***. Davidovsky, who is the present artistic director of the Harvard Computer Music Center, began his exploration of electronics combined with live performer(s) in 1962, following the inaugural concerts at Columbia. No doubt, the term *synchronisms* refers, somewhat, to the polarity of acoustic sounds, as produced by a live performer, with those created or manipulated by electronics.

Mario Davidovsky

In ***Synchronisms No.1*** for flute and tape (1963), one of Davidovsky's main focal points is the synchronization of rhythm between the two contrasting mediums:

> Vertical control of the timing between flute and tape is maintained in the overlapping shorter sections, while in the longer overlapping ones, a degree of vertical flexibility is introduced to accommodate the inevitable time discrepancies that result between the live performer and the constant speed of the tape recorder.[15]

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[15] Antokoletz, op. cit., P. 464.

Though the interplay of rhythm appears to be an integral component of Davidovsky's compositional technique, it is certainly not his only consideration. Articulation, dynamics, registral exploration, as well as the obvious attention to timbral possibilities, all contribute to the effective realization of each of the *Synchronisms*. Thus, every one utilizes a different instrument or ensemble format with which to explore. Other than the aforementioned work, the combinations include, **No.2** for flute, clarinet, violin, cello, and tape (1964), **No.3** for cello and tape (1964), **No.4** for chorus and tape (1966), **No.5** for percussion and tape (1969), **No.6** for piano and tape (1970), **No.7** for orchestra and tape (1974), **No.8** for wind quintet and tape (1974), **No.9** for violin and tape (1988), and, most recently, **No.10** for guitar and electronic sounds (1992).

The penultimate work, *No.9*, is the main focus of an in-depth study of effective preparatory techniques

for violinists, discussed in the next chapter. In order to show the complex nature of preparation involved in performing *Synchronisms No.9*, it is necessary to compare it with works and passages from traditional violin literature, as well as other pieces for violin and tape. This process serves to extract effective training methods from a less familiar, complex musical genre, by comparing its similarities and differences with that of more familiar literature.

Chapter 2

A Comprehensive Study of Techniques used in the Preparation of *Synchronisms No.9* for Violin and Tape by Mario Davidovsky

Preliminary Preparatory Issues

Mechanics versus Technique

Prior to discussing specific procedures used in the preparation of *Synchronisms No.9*, it is important to first recognize the idea of *preparation* as a tangible, comprehensible process. The term *technique* is generically used to represent "... the degree of skill or command of fundamentals exhibited in a performance."[16] Unfortunately, this definition does not reveal any specific, preparatory information regarding

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[16] Webster's II New Riverside University Dictionary (Boston, Ma.: Houghton Mifflin Company, 1984), p. 1188.

the precise execution of a work, or the achievement of a high level of technique. Furthermore, the present stigma of the word seems to evoke reference to an exclusive class of performers, who are *gifted* and *talented* enough to be worthy of being labeled as "...having great technique."

In reality, the concept of technique should reflect a clear understanding of the movements or actions necessary for the execution of a series of events. This implies that each of the basic movements necessary for a performance on the violin, such as finger and bow placements, must be explored on an intimate level, avoiding the confusion attributed to the mixing of tasks. William Starr, noted advocate of the ***Suzuki method***, writes (in reference to the characteristics of a good teacher), "In addition, he should, of course, know how to teach the child step by step in the intricacies of violin technique."[17] Although the integration of tasks is necessary, it is

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[17] William Starr, The Suzuki Violinist (Knoxville, TN.: Kingston Ellis Press, 1976), p. 13.

advisable to have one major focus at a time. The ultimate goal is to construct a complete, error-free mental and physical picture of performance, based on the clear, methodical working out of the smaller pictures. "When we are confronted with a difficult task, we can break it down into a series of patterns that are easy and familiar."[18] Therefore, the word *mechanics*, meaning "the technical and functional aspects of an activity"[19], seems to be more appropriate than the more ambiguous term *technique*, as the basis for the achievement of tangible, effective performance skills.

Synchronisms No.9: Areas of Training

It is this term, mechanics, that provides the violinist a firm foundation from which to choose a logical course of study when preparing a work, such as *Synchronisms No.9*. Thus, a knowledge of traditional

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[18] Barry Green, The Inner Game of Music (Garden City, NY.: Anchor Press/Doubleday, 1986), p. 35.

[19] Webster's II, op. cit., p. 737.

schemas, including various diatonic scales and etudes, proves to be somewhat ineffective when dealing with modern tape works, since it represents only a narrow spectrum of understanding. In fact, *Synchronisms No.9* requires two distinct areas of training, specific to its compositional makeup. As just stated, the first deals with mechanics. Such issues include the translation of notation into fundamental, numerical patterns, either vertical or horizontal, the precise mathematical calculation of shift and *leap* distances, precise bow movements which correspond to the dynamic and timbral nuances of electronic sounds, and the execution of other various instrumental effects.

The second area of instruction deals with issues pertaining to the 'synchronization' of the violinist with the tape part. Due to the complex structural nature of Davidovsky's writing, the precise understanding of meter and rhythm are integral to the stability of performance. As well, upon the development of a keen sense of rhythm, it is mandatory to explore the *aural makeup* of the tape, including the

recognition of ***aural cues***, which are crucial to the successful interplay between violin and tape. Balance, positioning, and the effective aural monitoring of the tape part are also important concerns for performance. Timbral issues, though coordinated with the tape, will be covered in the following section on mechanics.

First-Hand Study

Given the lack of a strict compositional system as even a secondary aid, *Synchronisms No.9* requires an exclusive ***first-hand*** study of instrument mechanics for its effective realization. Such an approach deals with the "translation" of *second-hand* information, such as written notation or a compositional system, into the direct, clear manipulation of the instrument. As mentioned, the first step is to break down each aspect of violin playing in order to develop a clear mental picture of each fundamental task. This philosophy of mental imagery is certainly not a newer innovation. The Suzuki method of training advocates, "Mental anticipation of the 'feel' ... and mental reflection on

the 'feel' ... are of crucial importance in the development of a fine technique ..."[20] The following represents an outline of the fundamental areas or pictures of violin mechanics, which must be considered for the success of performance:

Example #1: outline of violin mechanics

Posture or Set Positions

1) ***General Body Posture***
   a) feet stance (placement and balance)
   b) upper body alignment with lower body
   c) general arm/hand alignments

2) ***Violin Hold***
   a) relative alignment to body (shoulder)
   b) clarification of left hand participation
   c) focal point(s) of chin on rest
   d) variances in chin pressure (i.e., during shifting)

3) ***Left Hand Position***
   a) various hand pattern shapes
      i) degrees of finger curvature
   b) thumb positions

4) ***Bow Hold***
   a) finger alignment for security and precision

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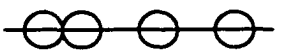
[20] Starr, op. cit., p. 126.

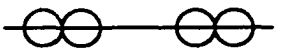
Left Hand and Arm

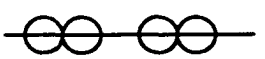
1) ***Basic Finger Patterns (based on half and whole-step relationships)***

a)  1,2 pattern

b)  2,3 pattern

c)  3,4 pattern

d)  1,2 - 3,4 pattern (wide)

e)  1,2 - 3,4 pattern (narrow)

f)  whole-step pattern

g)  half-step pattern

h)  1,2,3 pattern

i)  2,3,4 pattern

2) ***Extended Finger Patterns***

a) derived from basic patterns with one or more fingers extended outside of *whole-step* hand frame

3) ***Multiple String Patterns***

a) derived from basic patterns with two or more fingers placed on different strings, simultaneously
   i) double, triple, and quadruple stops
b) also used in conjunction with extended finger patterns

4) ***Shifting***

a) preparation
b) simple shift (involves one finger)
c) compound shift (involves two fingers)
   i) "shift-drop"
   ii) "shift-displace"
d) distance guides

5) ***Vibrato***
   a) hand mechanism
   b) arm mechanism
   c) various degrees of intensity

6) ***Left-Hand Pizzicato***

7) ***Harmonics (finger configuration and pressure)***
   a) natural
   b) artificial

Right Hand and Arm

1) ***Movements Governing Bow Manipulation***
   a) elbow height = main support over string plane
   b) upper arm = large, slow motions
   c) forearm = medium motions
   d) hand (wrist) = small motions (quick note values)
   e) fingers = tiny, fast motions (tremolo, etc.)

2) ***General Bowing Motion***
   a) "straight" bow = alignment to bridge

3) ***Bowing Paths or "Lanes"***
   a) on or near bridge = sul ponticello
   b) between bridge and fingerboard
   c) various degrees over fingerboard = sul tasto

4) ***Bow Distribution or Division***
   a) precise placement of bow
   b) precise calculation of bow usage

5) ***Bow Arm/Hand Weight***

6) ***Bow Speed***

7) ***Bow Change Process***

8) Bow Stroke Types

a) normal back and forth = Détaché
b) back and forth with separation = Staccato
c) controlled bouncing = Spiccato
d) "pinched" bow types
  i) successive hooked = up and down bow Staccato
  ii) quickly (separated) at balance point = Sautillé
  iii) followed by bow speed = Martelé

e) thrown bow = Ricochet
f) hooked notes with individual pulses = Portato
g) rapid hand movement = Tremolo
h) finger plucking = Pizzicato
i) with wood of bow = col legno tratto
j) struck with wood = col legno battuto

Other Effects

1) Snap Pizzicato
2) Knocking on Instrument With Hand
3) Bowing Behind Bridge

Rhythm

1) Precise Subdivision of Units

a) counting "plan" (based on different degrees of subdivision)

Computer-Tape Related

1) Translation of Notation (into precise movements)
2) Listening Skills

a) listening "plan" (based on audible cues, etc.)
b) awareness of timbral relationships
  i) various textures (metallic, wood, plastic, etc.)

Dispelling Preparatory Stigmas

The previous outline will serve as a reference for the development of effective preparatory techniques, with regard to *Synchronisms No.9*. The initial goal is to dispel all erroneous notions or stigmas attached to present modes of preparation. Again, since the music, for the most part, has no correlation whatsoever to any prior system of composition, it mandates that the focus of preparation be shifted back to its origin, namely, fundamental mechanics. This is most beneficial, since the knowledge of a *finished product*, which assumes a mere aural or stylistic familiarity, can be the subtle bane that restricts the violinist from effectively negotiating a new piece of music on a consistent basis.

Due to the fact that *Synchronisms No.9* does not reflect established conventions of melody, harmony, and rhythm, it is unlikely that the performer will inadvertently rush his or her preparation. Poor practice habits, including the implementation of *premature* time constraints, are mainly attributed to a subtle desire to achieve the finished product as

quickly as possible. Unfortunately, this mode of thinking, consciously or subconsciously, seems to be the major cause of most errors and miscalculations. Fortunately, however, the new musical territory explored by *Synchronisms No.9* provides a perfect forum for the formulation of effective practice strategies and techniques. Since the notation does not follow any set rules of traditional writing, the performer must carefully and methodically translate the symbols into understandable, mechanical information.

Foundation for Effective Practice Ethic

In fact, the violinist who chooses to undertake the challenge of preparing *Synchronisms No.9* is perhaps unknowingly laying down the foundation for a more effective overall practice ethic, due to gamut of resources utilized by Davidovsky in the work. This path begins with the dissolution of any sense of time or tempo restriction, as recently suggested. Since the role of the performer is an active one, demanding the

flawless execution of tasks, he or she is not at liberty to prepare in a manner in which *arbitrary errors* can exist. Of course, the term error must be distinguished from that of *experimentation*, which is a controlled environment for the exploration of different performance options or executions. Renowned violin pedagogue, Paul Rolland, when referring to a certain type of bow motion states:

> "In *sautillé* bowing, the player should not throw the bow intentionally but should *let* it bounce. The best spot for bouncing can be found by experimentation."[21]

However, once a technical decision has been made, it must be executed precisely on a consistent basis, thereafter, unless the performer implements another change. This ensures clarity of execution and consistency of performance. Thus, any factors that hinder this goal, such as time or tempo, must be removed.

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[21] Paul Rolland, The Teaching of Action in String Playing (Urbana, Il.: Boosey & Hawkes, 1986), p. 172.

Proportional Relationships

In reality, the concept most crucial to the *integration of mechanics and musicianship*, at the preparatory level, is that of focusing on correct ***proportional relationships***. This idea applies to mechanical areas such as shift distances, and bow usage (division and distribution). The execution of events in a *slow-motion*, error-free environment, allows the performer to express creativity and musicality without having to make sacrifices for tempo markings. Due to the methodical repetition of tasks with regard to sequence, not time, the mind and body develops an intimate understanding of the sequences, in the form of clear ***mental pictures***. Again, Paul Rolland writes:

> "*In the 'shift-stroke' the interval played is always larger than the distance traveled*, and the size of the interval must not create a mental image of an unnecessarily long shift."[22]

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[22] Paul Rolland, Basic Principles of Violin Playing (American String Teacher's Association, 1979), p. 30.

Though I personally use slightly different terminology when referring to shift types, as will be discussed later, the general concept is the same. As these mental pictures get clearer, along with the touch or ***tactile memory***, the performer is able to confidently manipulate the ratio of the events, proportionally. Thus, the *compression* of these events manifests itself to the listener as a faster tempo. Since the violinist is not actually perceiving this compression in a temporal sense, as such, the result is an exact duplication of the original preparatory process. This includes all of the associated qualities such as clarity, comfort, and focus of execution. This result is in staunch contrast to that which is commonly labeled in music as *rushing*, or the lack of effective control over the desired execution of events due to "... anxious and impatient movements."[23]

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[23] Webster's II, op. cit., p. 1027.

Comparison of Works

It is necessary at this juncture to compare excerpts from Mario Davidovsky's ***Synchronisms No.9,*** with those of works exhibiting a more traditional compositional approach, as well as other violin and electronics pieces. An in-depth comparison, such as this, in necessary for the formulation of a specific preparatory strategy for Synchronisms No.9, based on the exploration of comparative data sources. The ***Ciaccona*** movement of the ***Partita in d minor*** for unaccompanied violin, composed by **Johann Sebastian Bach**, will serve as the main representative of the traditional, diatonic style of violin writing. This work displays various examples of patterns and structures which bear a relation to those found in *Synchronisms No.9*.

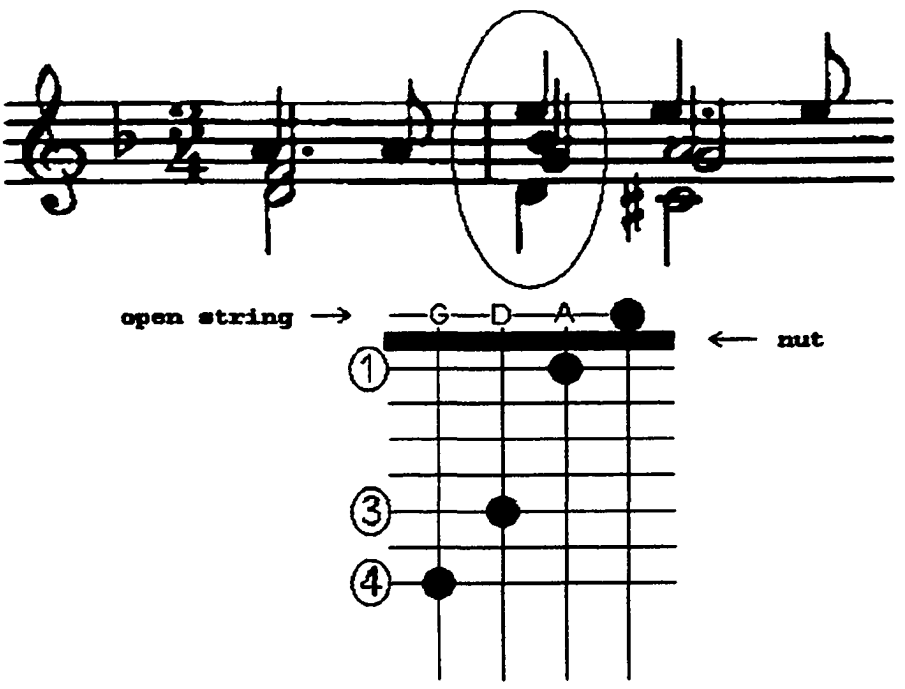
Example #2: Bach Ciaccona (ms. 4-8)

Example #2 shows verticalities or chord structures, which are based on a *diatonic* compositional system, reflecting the tonal area of *d minor*. Though this information may be helpful in some ways to the performer, it does not prove too useful in determining the precise manner of execution of these structures. Furthermore, the visual notation itself represents second-hand information, which is an indirect means of conveying clear, manipulative processes.

Chord Tablatures

Example #3 represents a more direct picture of the finger placement required for the second chord of example #2. The picture below the notation indicates the precise location of each finger by dividing the fingerboard into *half steps*, which are the smallest units of distance employed by Bach in this work. As a result, the violinist has a tangible mental guide or ***tablature***, a term commonly used with reference to the illustration of guitar chords, built upon half-step

Example #3: chord tablature



intervals. Rolland writes, "...the student first may learn materials by rote or tablature, then learn the same material by note reading."[24] This strategy works especially well when applied to the violin, which, due to its size, allows for a *one-to-one ratio* between the fingers and stepwise motion. In general, the violinist

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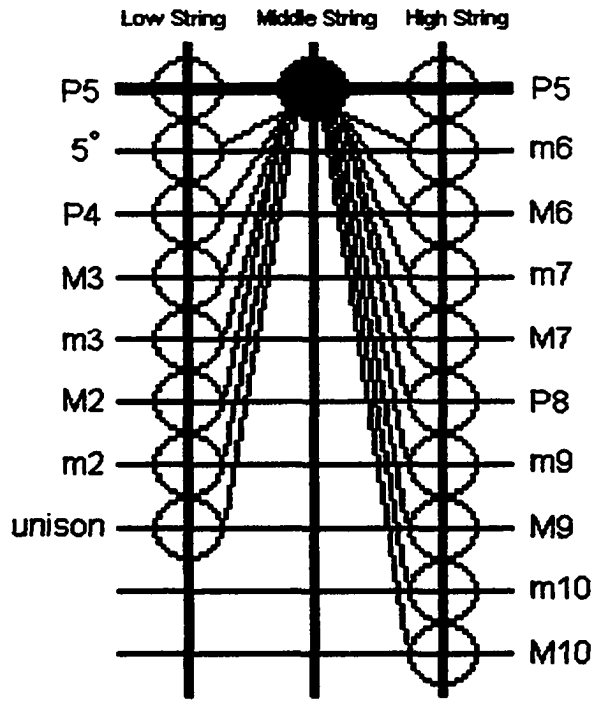
[24] Paul Rolland, Prelude to String Playing (New York, NY.: Boosey & Hawkes, 1971), p.1.

needs only to determine whether or not to place a space between the fingers, thus producing a whole or half step, respectively. Example #4 shows the various intervals over two strings, generated from half-step units. The idea of subdividing larger structures into recognizable parts is also applicable to other facets of performance, especially that of bowing and rhythm (discussed later).

Example #4: tablature of intervals
(based on half-step units)



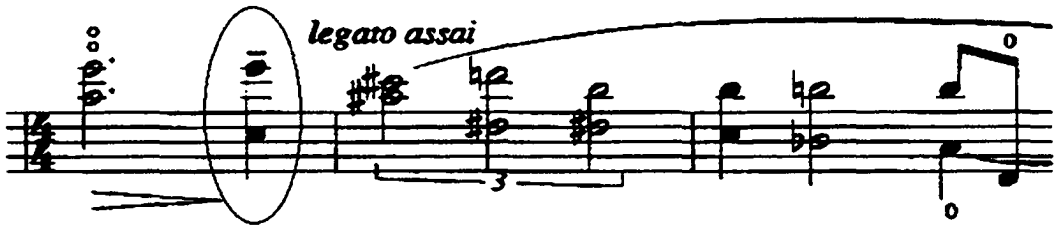
Although the tablature used to clarify the chord in the Bach *Ciaccona* (example #3) seems to be a clearer representation of finger position than the original notation, it certainly does not reflect a complete process of execution, however. Whereas most double stops, or 2-note structures, can be executed almost simultaneously, certain triple and especially quadruple stops may necessitate a subtle *ordering* to the placement of the fingers, according to the complexity of the hand configuration. This ordering is generated from a focal point, which I refer to as the *guide note*. It is common to utilize two fingers as a *guide note group* when negotiating triple or quadruple stops. For instance, the chord used in example #3 has various possible focal points. If the lowest note (4^{th} finger) is used as an initial guide for the placement of the rest of the fingers, the center of hand balance shifts accordingly. Consequently, this may result in an uncomfortable, incorrect placement of the first finger. If the violinist desired to break or roll the chord, from low to high, then the hand balance could *roll*

along with the bow, achieving a convincing remedy. Another option would be to use the middle two notes (3rd finger on **D** and 1st finger on **A**) as guides. In this case, although the hand would be centered in terms of balance, the result might be a more difficult reach for the 4th finger, due to its length, which is typically shorter than the rest of the fingers. Thus, considerations such as hand size, preference of execution, and the fluidity of finger movement between multiple-note structures, are important factors in determining one's ultimate choice of performance.

Verticalities in Synchronisms No.9

This manner of approaching the configuration of left-hand shapes is by no means limited to the diatonic realm, as exemplified by the Bach Partita. Example #5 shows double stops found in *Synchronisms No.9* of Mario Davidovsky. The use of the guide note concept is similarly required for the successful execution of the second structure, which follows an initial double stop. Although structure #2 (circled) contains *only* two notes,

Example 5: Synchronisms No.9 (ms. 3-5)



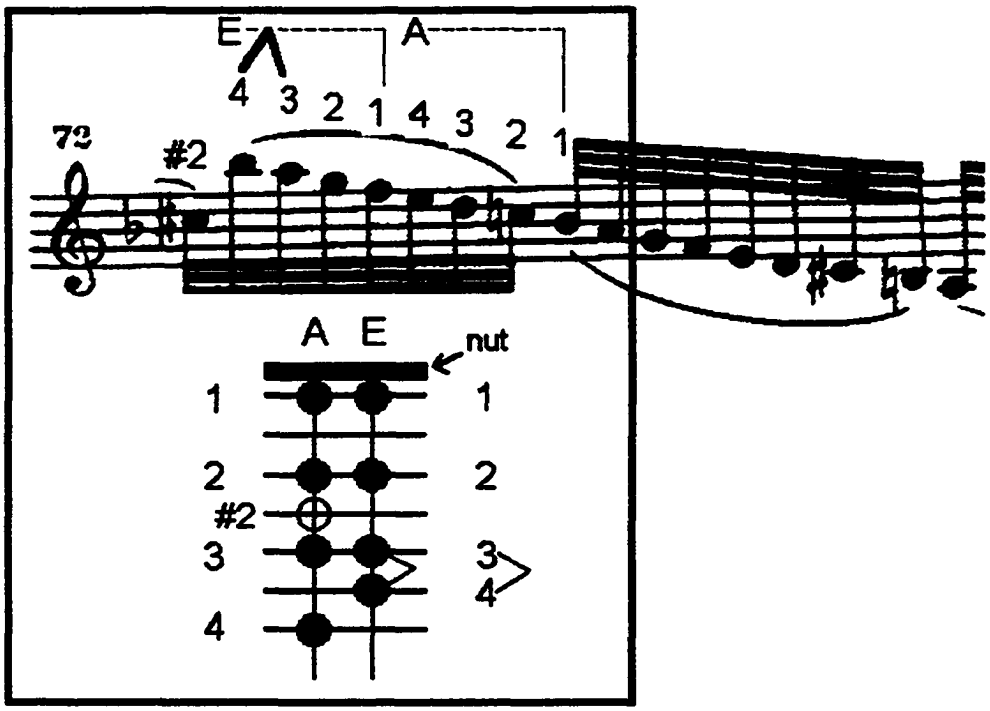
it requires an extended hand position, making the proper placement of fingers more difficult. Since the written interval of a major 10th represents the practical limit of the violinist's range, the 1st and 4th fingers must be used for a successful execution. Contrary to the general idea of building upward from a base or root foundation, it is most effective to use the 4th finger as the guide note. This is due to the ease at which the 1st finger is able to reach backwards from an anchored 4th finger, as opposed to the impracticality of reaching upward. As mentioned, the 4th finger is generally much shorter and weaker than the other fingers, and may detract from the confident placement of large, extended intervals.

Linear Motion

Similar to the study of multi-finger or *vertical* structures is the intervallic exploration of horizontal patterns. The tablature concept is most applicable to linear events as well as verticalities (see example #1: Left Hand and Arm). In fact, scale-type constructions are more basic in that they require the movement of one finger at a time, as opposed to the movement of multiple fingers, simultaneously. Also, the one-to-one finger/step relationship, mentioned earlier, proves to be an effective gauge for the calculation of linear passage work on the violin. This feature has its advantages especially when trying to *translate* scalar notation obscured by the modern, non-diatonic, use of accidentals, etc.

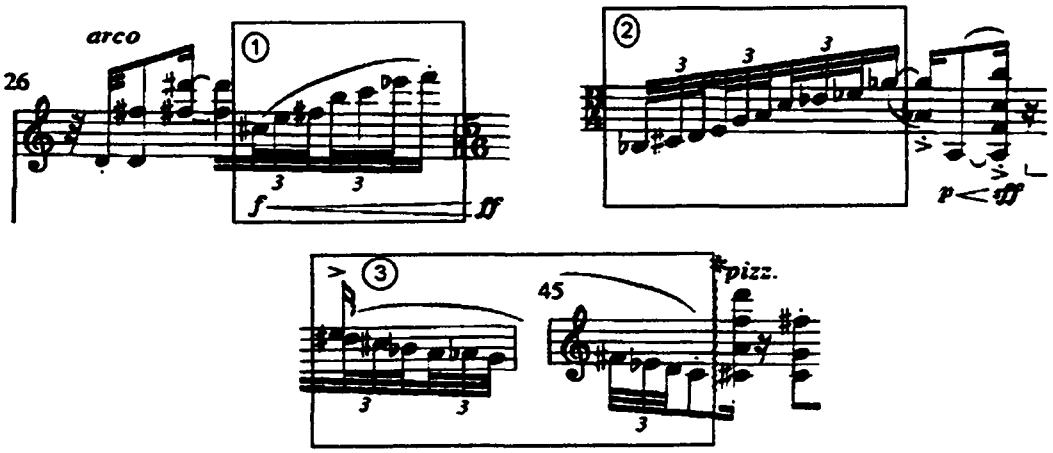
Example #6 illustrates a diatonic scale passage found in the Bach *Ciaccona*, clarified by a tablature. Example #7 shows various passages, similar in nature, though not diatonic, found in Davidovsky's *Synchronisms No.9*. The fact that each composer employs a totally

Example 6: Bach Ciaccona (ms. 72)



different system of composition is irrelevant to the execution of these patterns. Even if the violinist has an intimate awareness of a composer's organizational structure, as might be the case with the Bach example, there is no assurance that this knowledge will be translated into correct physical motions on his or her instrument. Again, the distinction between

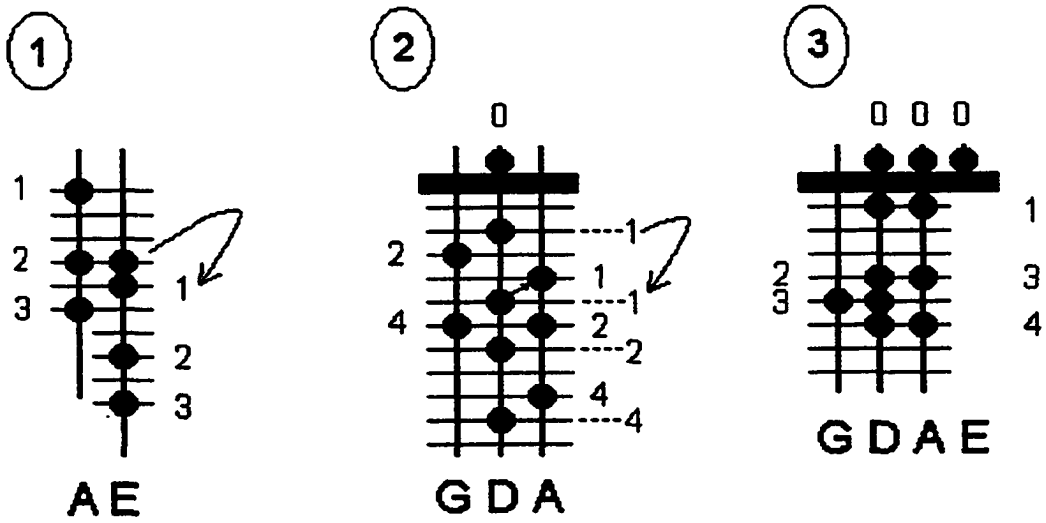
Example #7: Synchronisms No.9 (selected measures)



compositional structure and that of instrument mechanics represents the difference between second-hand and first-hand information.

The following tablatures show a more first-hand realization of the three Davidovsky excerpts presented in example #7. The first picture clearly shows a repeated finger pattern separated by a displacement shift **(1--2-3)**. Note the extra half step between the first and second fingers; this is an ***extended*** fingering because there exists more than a whole step between two

Example #8: linear tablatures of excerpts in example #7



consecutive fingers. The second tablature incorporates a similar idea of pattern repetition as the first. In this case, the grouping is **1-2--4**, which is separated by a simple shift; note the partial pattern **[2--4]** on the G string. The last picture differs from the first two in that the pitches are executed in descending order starting from the top. The direction of horizontal movement can be unclear on a tablature, in that linear patterns frequently change directions, although they happen to be unidirectional in each of

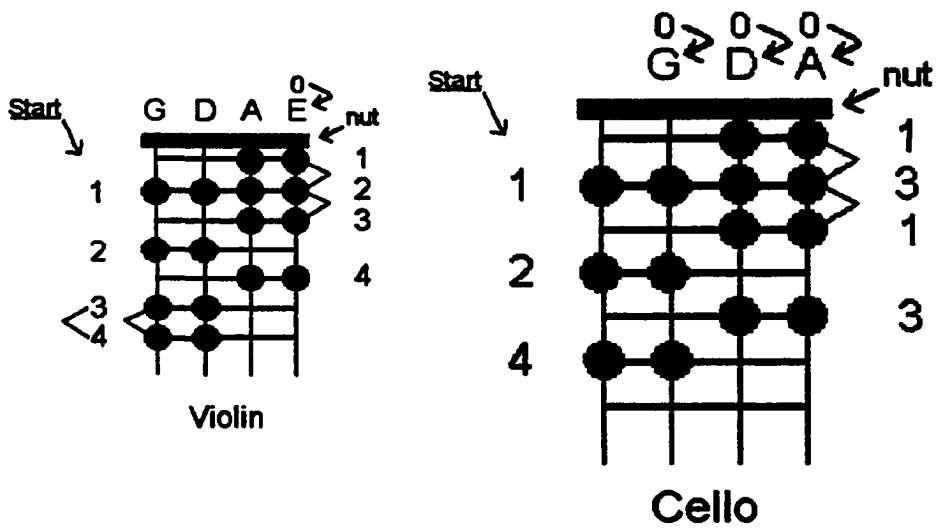
these three examples. Another distinguishing feature of the third diagram is that the initial pattern is not repeated, as in the case of the first two. Interestingly enough, the overall structure certainly appears clearer than those of tablatures one and two because it is limited to one position. In reality, the D string is subtly altered, requiring a total shift in hand frame. This involves a re-placement of the third finger next to the fourth, while the second finger moves up to the original third finger location. The result is an extended finger pattern similar to the first example (**432--1**).

Contrasting Linear Approaches

When discussing linear left hand movement, as in the previous examples, it is important to reiterate the concept of the one-to-one relationship between the fingers and stepwise motion. As stated earlier, this is most beneficial, since *Synchronisms No.9* employs a minimal distance of a half step, corresponding roughly to the width of an adult finger. Remember that whole

steps are achieved simply by spacing the fingers apart. Thus, the execution of stepwise motion on the violin reflects, more or less, consecutive finger movement, regardless of spacing or registral position, unlike that of larger stringed instruments, such as the cello. Of course, repeated patterns can occur on both instruments, allowing each performer to formulate effective linear *fingering plans*. Example #9 compares the two instrument approaches to a scalar passage.

Example #9: comparison of violin and cello linear motion



The first half of the passage, beginning from the bottom, is simply a major scale, while the latter is non-diatonic, without any implied relationship to a formal compositional system. Upon further review of the tablatures, it is evident that the violinist is capable of implementing a more rudimentary approach than the cellist, in terms of motion and energy. The first consideration is the idea of consecutive finger movement, as recently discussed. Regardless of the contrast between the two patterns that form the entire linear structure, which is divided by string pairs, the violinist enjoys a simple, numeric progression of finger movement. Thus, in either case, the fingering is still first, to second, to third, and to fourth. Since the size of the cello is many times that of the violin, it would not be prudent for a cellist to adopt the violinist's fingering, especially in that the spacing is the widest in first position. Another convenience afforded by the violin part is that there is no shifting involved, contrary to that of the cello. Obviously, shifts require extra energy to execute due

to the extra motion involved. Lastly, if this hypothetical passage were written in some sort of duple meter, where the initial first finger began on a strong beat, the string crossings of the violinist's bow would effectively line up with the metric pulse.

Despite what could be construed by violinists as *handicaps*, the cello passage in example #9 utilizes an important universal concept, which adapts especially well to the playing of stringed instruments, in general. This is the idea of *finger pattern recycling*:

> "A repetitive pattern of fingering is an efficient vehicle for security in memorizing and obtaining accuracy since the configuration of the fingers hardly changes while the digital order remains constant."[25]

Similar to the fingering scheme of the violin, the cello utilizes an effective paired repetition of fingerings. As well, the non-diatonic section integrates the shifting procedure into the linear

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[25] Dr. William Hayden, Principles of Bowing and Fingering for Editing Violin Music (Muncie, IN.: dissertation, 1981), p. 62.

design. Thus, the translation of unfamiliar scalar motion, as found in works such as *Synchronisms No.9*, is greatly aided by the extrapolation of repeated motivic groups. This approach to linear writing enables the cellist, violinist, as well as other related string instrumentalists, to properly execute such passages on a consistent basis.

Shifting

Another important area of technical or mechanical consideration for the execution of *Synchronisms No.9* is left hand position movement, such as shifting and quick register or position changes. In order to achieve precision in this area it is necessary to utilize resources other than the mere *feel* of a shift motion, for example. Since tactile memory is part and parcel of left hand technique, and implies a rote manner of operation, it is imperative for the violinist to be able to comprehend precise distances in a tangible manner, as well. "Mathematical calculation of the

right distance between the different positions as expressed in fractional parts of inches is obviously possible."[26] This concept is applicable to all music, but especially important to a piece like *Synchronisms No.9*, where numerous shifts and large intervallic leaps pervade the entire work. Note that in the above quotation, Carl Flesch uses inches as reference points for distance. However, in my opinion, it may be more useful for a violinist to maintain a conception of the inherent finger/half step relationship.

Thus, the guide-note concept plays an important role in the successful execution of position changes. Whereas guide notes are realized mainly as tactile for the formation of chordal structures, as discussed earlier, they can also be perceived as *aural* and *visual* cues when applied to the changing of positions, as will be shown later. Of course, the tactile measurement of distance is still the violinist's major guiding force in the area of shifting. This is mainly due to the

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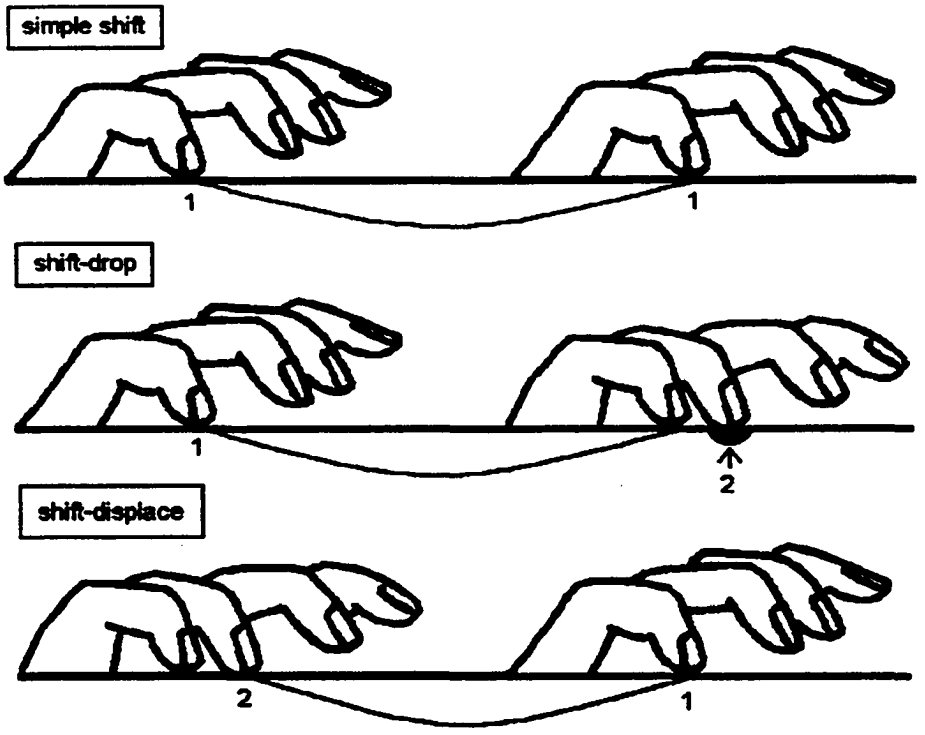
[26] Carl Flesch, The Art of Violin Playing (New York NY.: Carl Fischer, Inc., 1939), p. 27.

lack of other tangible aids or reference points, such as the *frets* on a guitar, which are visual.

Shift Types

The three basic shift types, mentioned in the outline of violin mechanics (example #1), are labeled

Example #10: diagram of shift types



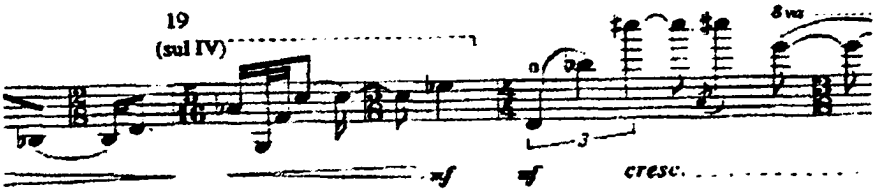
simple, *shift-drop*, and *shift-displace*. The reason for these distinctions is due to the important procedural differences that are entailed. Whereas the simple shift involves the use of a single finger, the other compound shifts necessitate an added procedure to complete their execution. Example #10 illustrates examples of each of the shift processes.

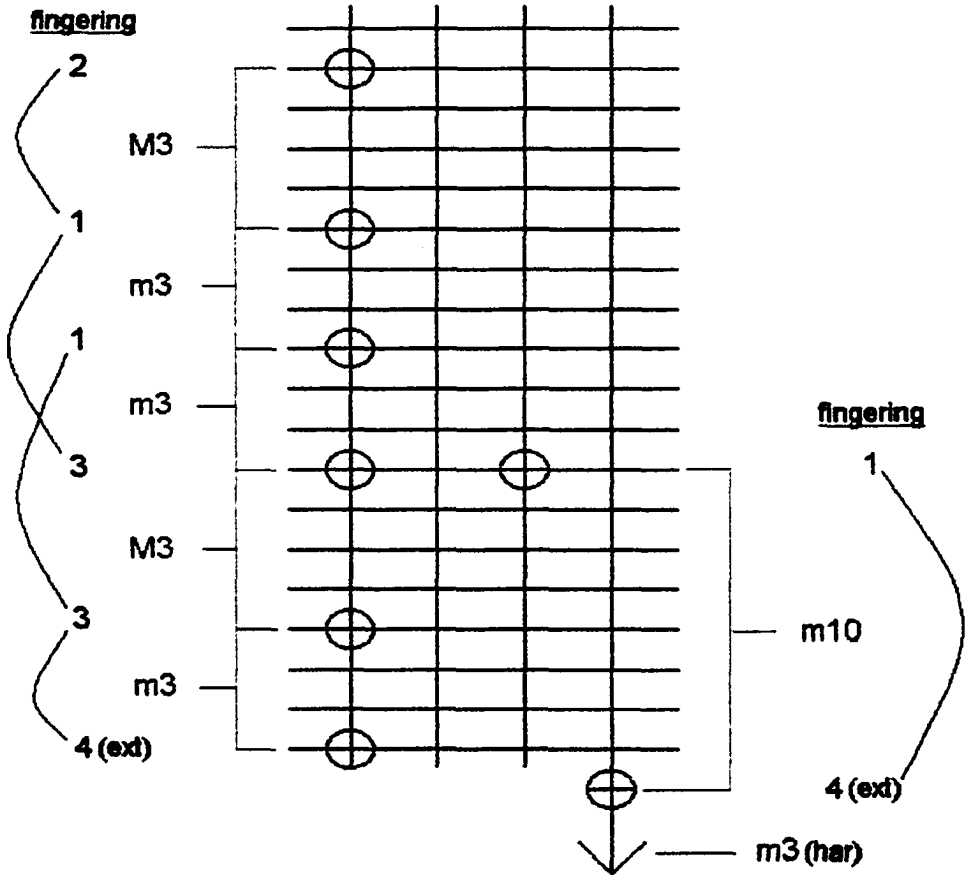
Shift Measurement

As mentioned, in order to achieve an effective tactile awareness of the fingerboard, with regard to shifting, it is important to develop a coexistent system of measurement to ensure consistent accuracy of the arrival pitch. In general, this may be perceived as a clear mental image of the distance between the two finger points, as corroborated earlier by Paul Rolland. Example #11 shows an excerpt from *Synchronisms No.9*, with a corresponding shift tablature.

A first impression of the notation may confuse the violinist into believing that the pitches jump all over the fingerboard in a purely arbitrary manner. Since

Example #11: tangible shift distance measurement





there appears to be no traditional rules governing the pitch motion, such as found in diatonic voice leading,

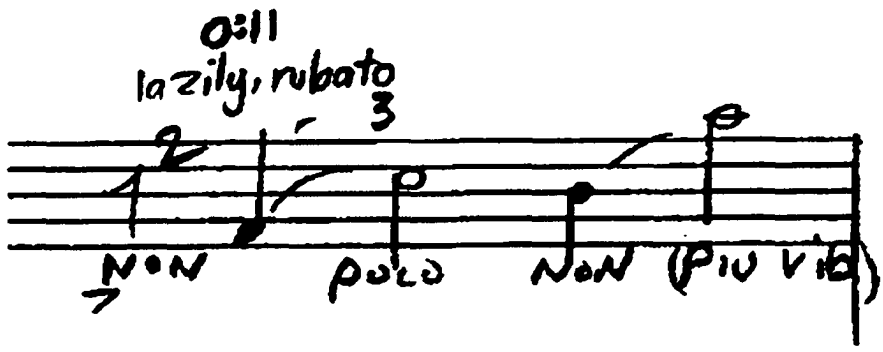
the performer must look elsewhere for structural security. In reality, the deciphering of the original notation reveals a very comprehensible treatment of intervals. Every fingered interval, beginning with the low B-flat all the way up to the high E-natural harmonic, is either a third or built upon thirds; this includes the perfect 5^{th} in measure 19 and the octave displacement in measure 21 (B-flat to C-sharp [D-flat]). This discovery made by the violinist is also the *unveiling* of an effective shift fingering scheme. The core shift mechanism is that of the first-to-third finger shift-drop, executed twice in succession at the opening of the passage. The open G string has no effect on position movement, as well as the other respective open strings which are woven into the framework.

Aural and Visual Shift Guides

Certain passages may necessitate the use of an aural or visual distance guide to assist in the precise

execution of a shift. An audible sliding of pitch, such as a *glissando*, is the perfect device for the use of an aural cue. In this case, the violinist can rely mostly on listening to determine the appropriate end of a shift. The opening of ***AM Fugue*** (1998) for violin and tape by **Kristin McGarity**, shown in example #12, exemplifies an appropriate use of aural guides.

Example #12: AM Fugue - opening
(use of aural cues or guides)



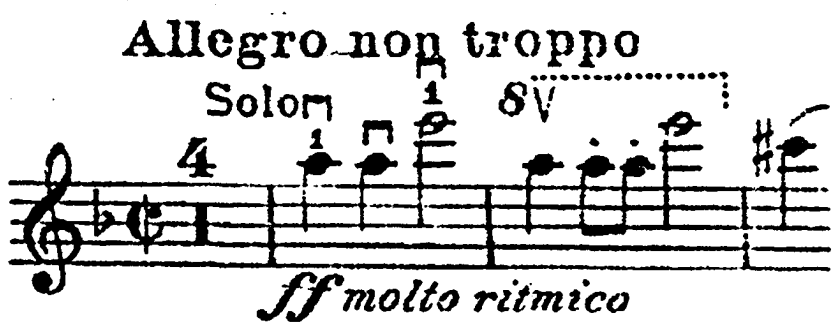
(note: these opening two gestures hint at a person *yawning***)**

While the incorporation of an aural guide can be very effective, there are many instances where the performer is not allowed this resource, due to the

nature of articulation or compositional style. In cases where the violinist is unable to incorporate aural cues, and tactile memory is not foolproof, there exists the possibility of using a visual aid.

The opening of the ***Symphonie Espagnol*** by **Édouard Lalo** illustrates the use of the visual guide concept as applied to the traditional violin literature. The

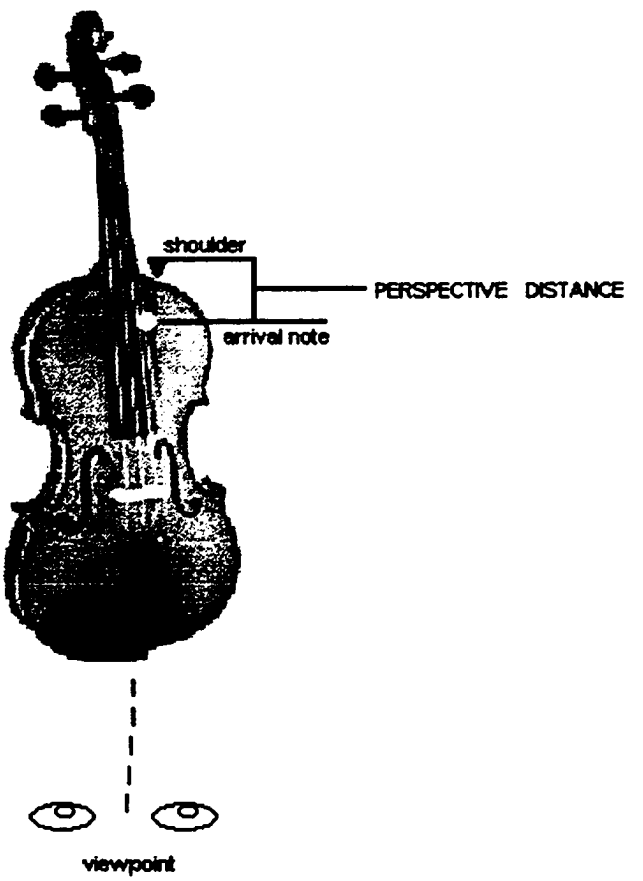
Example #13: Symphonie Espagnol - opening



execution of the opening interval (perfect 5th) is not conducive to using an aural guide because the consecutive down bow articulation makes it extremely difficult to hear the pitch progression up to the arrival point. Also, since it is necessary to use the

first finger exclusively for the execution of the initial shift, due to the continuation of upward register movement, tactile memory may not be enough to ensure consistent precision. Thus, determining the placement of the arrival point of the first finger can

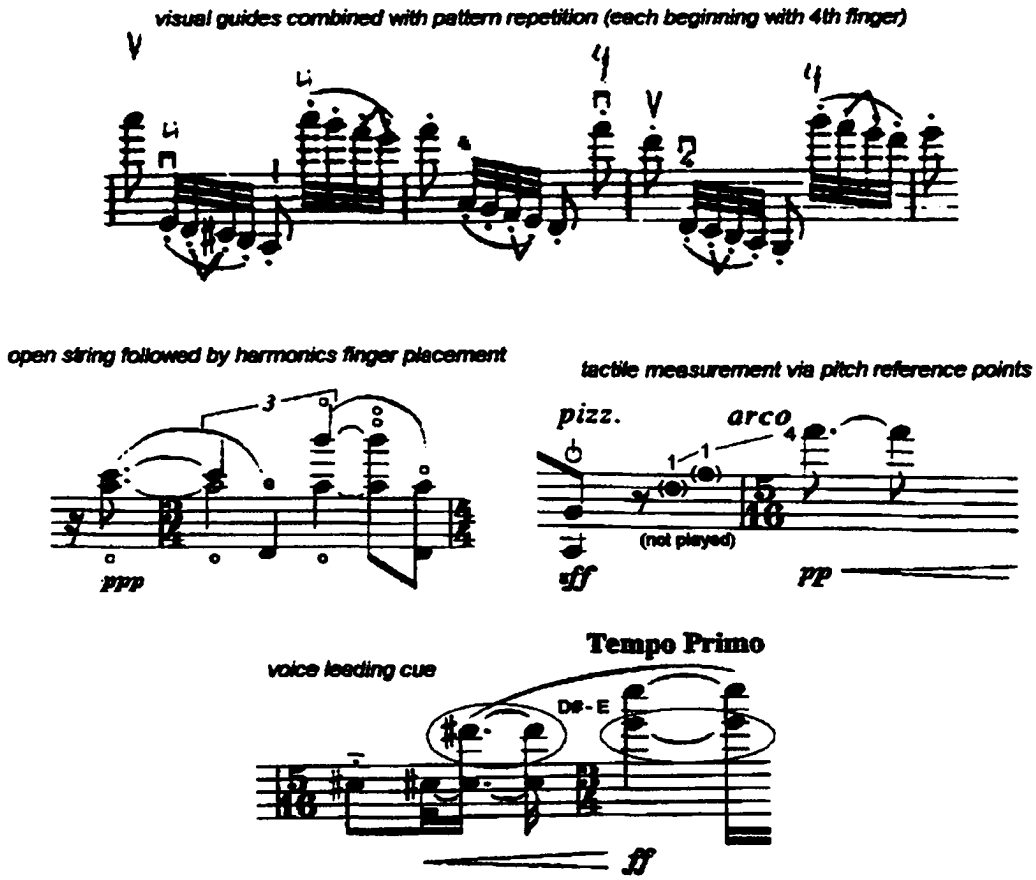
Example #14: diagram of the visual guide concept
(as applied to the opening of Symphonie Espagnol)



be achieved by its visual relationship to another part of the violin, such as the *shoulder* of the instrument (example #14).

Example #15: miscellaneous approaches to register changes

(passage from *Caprice No.9* for solo violin by Niccolo Paganini)



(selected measures from *Synchronisms No.9* by Mario Davidovsky)

Miscellaneous Approaches To Register Changes

Another variation of a large register change is the leap of a wide interval crossing over two or more strings, such as 1st position on the G string to a high position on the E string. Situations where a conventional shifting procedure is not feasible require ingenuity to achieve correct results. This idea is certainly a common occurrence in *Synchronisms No.9*, but also exists in traditional literature, as well, typically found in works displaying extreme virtuosity. Example #15 displays various approaches to the execution of unconventional changes of position.

Bowing And Related Effects

Until now, this treatise has limited its exploration of *Synchronisms No.9* to the mechanics of the left hand and related parts. This is mainly due to the extensive role that the left hand plays in the manipulation of the violin. However, it is also

necessary to discuss effective approaches for bowing, including the execution of miscellaneous timbral effects, as well as specific tape-related ideas, such as timing and rhythm, balance, media positioning, and tape monitoring.

Firstly, the proper use of the bow presupposes that the violinist feels secure in the manipulation of its total range, from frog to tip. Though this idea may appear to be somewhat simplistic, the training of the bow arm to provide effective support over each of the strings and bow locations can be a very complex issue. "The bow-stroke is produced as the result of the following movements of the individual parts of the right arm:

1. A vertical movement of the upper arm in the shoulder-joint
2. A horizontal movement of the upper arm in the shoulder-joint
3. A rolling movement of the lower arm in the elbow joint
4. A horizontal movement of the lower arm in the elbow joint
5. Wrist movement
6. Finger-stroke[27]

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[27] Flesch, op. cit., p. 54.

In addition to Flesch's itemization of the many motions producing a single bow stroke, there are also a wide variety of arm angles and string approaches to contend with, as well as the drastic change in hair tension at different parts of the bow. This treatise, however, will assume that the performer has a basic proficiency in the horizontal movement of the bow, and is capable of utilizing its full capacity.

Bow Division and Distribution

The concept of bow division, crucial to the precise execution of Davidovsky's complex dynamic scheme, is certainly not a new issue. Similar to the idea of placing tapes on the fingerboard for the visualization of patterns, the Suzuki method also advocates the use of tapes to delineate the placement and distribution of the bow:

> Teachers drop the use of tapes at different times with their students. Some use them only at the beginning. Others use tapes for a long time... as they give the student

specific instructions regarding bow distribution for each piece.[28]

Since the use of these tapes are temporary, the assumption is that the violinist will develop a memory of proper finger and bow positioning. The fact that tapes represent a visual aid signifies that mental imagery appears to be integrated together with the tactile sense, producing a composite form of memory.

Example #16 shows an excerpt from *Synchronisms No.9*, along with a possible realization of bow placement and distribution. The major consideration in determining bow usage is the *dynamic scheme*. Notice the distribution of the third bow stroke in this example. The lower case letters (**a** -> **b** -> **c**) represent the amount of bow used per quarter note subdivision of the slur. Though each letter reflects a quarter note of time, letter **c** requires twice as much bow in order to execute the subtle crescendo. Also, since the crescendo moves only to a mezzo forte, and is followed

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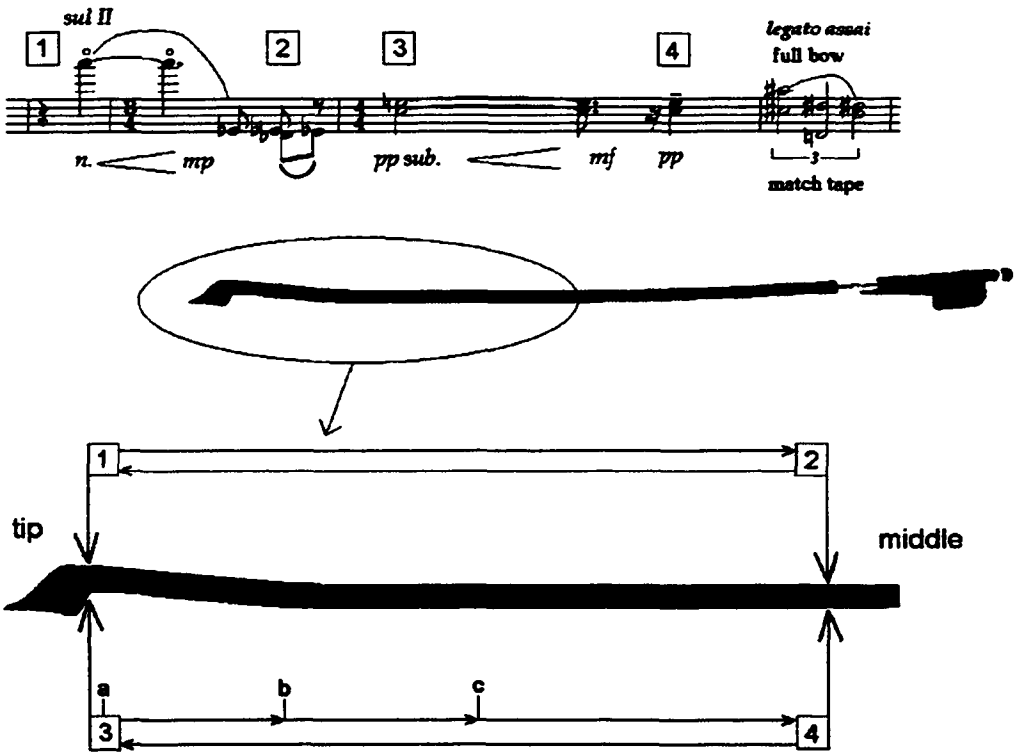
[28] Starr, op. cit., p. 59.

by a subito pianissimo in the fourth bow stroke, it would be unwise to travel past the middle in order to exaggerate the *mf* crescendo. Decisions such as this are crucial to the proper realization of the composer's intentions.

Example 16: Synchronisms No.9 (ms. 218-221)
(including diagram of bow distribution)



Effects

Part and parcel of Davidovsky's detailed attention to dynamics, is the intrusion of various bow and other types of timbral effects. Obviously, this corresponds directly to the large palette of electronic timbres employed in the tape part of *Synchronisms No.9*. Thus, the earlier concept of bow placement and distribution must also allow for the execution of these kinds of inflections. These are typically achieved by the subtle, appended manipulations of hand and finger parts, as applied to the general framework of bowing. Such ideas include ponticello bowing, ricochet bowing, various types of bow accentuations, and various types of pizzicati, including snap pizzicato, left hand pizzicato, and left hand pizzicato coordinated with bow movement. Other works for violin and tape, including *AM Fugue*, utilize miscellaneous special effects, such as exaggerated glissandi (discussed earlier), extremely wide vibrato, and various instrument *knocks* or *taps*. Effects like these provide further cohesion between the two opposing mediums.

Performer and Tape Synchronization

Aural Evaluation

The final integral area of study for the mastery of an electro-acoustic work, such as *Synchronisms No.9*, is that of the synchronization and logistical coordination of performer and tape. Whereas in traditional styles of composition this idea consists mainly of rhythm and articulation, a crucial factor when synchronizing with a predetermined tape part is that of aural awareness. In such cases, where traditional metric values are used, it may be necessary to incorporate some form of isolated rhythmic training, depending upon the complexity. However, certain electro-acoustic works employ a freer sense of meter and rhythm, such as chance or improvisation, where normal rules of counting do not apply. Furthermore, tape parts which portray a clear metrical structure, such as the opening measures of *Synchronisms No.9*, may not be as precise as indicated in the score. Thus, the success of the ensemble between violin and tape

ultimately relies on an effective aural evaluation by the performer.

The success of this evaluation relies on the violinist's ability to effectively interpret and react to a wide variety of electronic sounds. As well, he or she must develop an almost *psychological* sense of time, which is crucial to the coordination of sections where the tape drops out and re-enters after a long period of silence. As with the study of violin mechanics, much repetition of local and larger sections with the tape is key to the aural training of the performer. This kind of practice develops and reinforces effective habits of timbre recognition, instrumental adaptation, and temporal anticipation and reaction.

Performance Logistics

Logistically, the aural evaluation must also take into account practical performance issues. Though composers, such as Davidovsky, offer some basic instructions on the setup of performer and tape, typically there is no regard given to specific

acoustical concerns. Such issues include hall size and acoustic properties, as well as provisions for the clear monitoring of the tape by the performer. The rapid, complex motion of events found in *Synchronisms No.9* mandates that the violinist hear every nuance in order to effectively interact with the tape during a performance. If it is not possible to place the speakers in a location suitable to both the audience and the performer, it may be necessary to utilize a second set of speakers solely for the benefit of the performer. These speakers, known as *monitors*, can be connected to the same ports as the main ones. However, it is preferable to employ much smaller, less obtrusive speakers, which should be positioned near, and facing, the violinist.

Balance

The issue of balance in electro-acoustic music for performer and tape is approached in a similar manner as that of a soloist with an orchestra. In a sense, the dynamic range of the tape material, as *performed* by an

electronic sound system, is comparable to that of a symphony orchestra. Consequently, there are similar considerations. Most importantly, the performer must first locate the outer points of dynamic energy, or the places which are softest and loudest, within the tape part. In light of this information, the violinist must determine whether or not it is necessary to electronically amplify his or her instrument, or to simply adjust the volume of the tape system in an appropriate manner. In the case of *Synchronisms No.9*, the dynamic range of the tape part falls within the acceptable limits of that of an unmodified, acoustic violin, allowing for a mere balance check prior to performance. On the other hand, a work such as ***Parallax 1 "Violin"*** (1996), composed by **Paul Rudy**, specifies the use of a separate microphone amplification system, since the tape part dramatically exceeds the dynamic capabilities of the violin. **Russell Pinkston**, the director of electronic music at the University of Texas at Austin, advises that composers should consider making different *versions* of

works for tape and live performer(s), catering to various performance circumstances, such as recital versus concert halls.

Meter and Rhythm

The synchronization of violin and tape may also require a more fundamental focus of preparation prior to dealing with the logistical issues previously discussed. If, in fact, the violinist does recognize that the composer is utilizing a system of intricate metrical changes and complex rhythms, as is the case with *Synchronisms No.9*, it is advisable to pay individual attention to this particular issue. This means that it may be necessary at first to prepare the rhythm itself separately from the mechanics of the instrument. As well, unless the performer learns the piece by rote or plays the work from memory, the internalization of the rhythmic structure must be tied in with the *translation of the visual notation;* upon viewing, the notation must immediately represent a

clear understanding of the rhythm, as well as the other parameters of execution.

An effective means for the precise training of rhythm is a *MIDI sequencer* or sequencing program, discussed in the first chapter. This assumes that the notation follows a somewhat standard compositional approach, as opposed to timed events, for example. Since the basic metronome is not sophisticated enough to allow for meter changes, as well as the sounding of irregular groupings, such as fives, sevens, nines, etc., the performer is advised to create a *click-track* using a sequencing program.

Typically controlled by a personal computer, a sequencer involves the input of notation, including pitch, rhythm, and most every other parameter. The consequent output, transmitted via speakers or headphones, allows the performer to hear an actual simulation of the work, and even focus in on individual parameters, such as rhythm. It also enables the large-scale, proportional shifting of a piece, allowing for different rates of execution. Since proportional

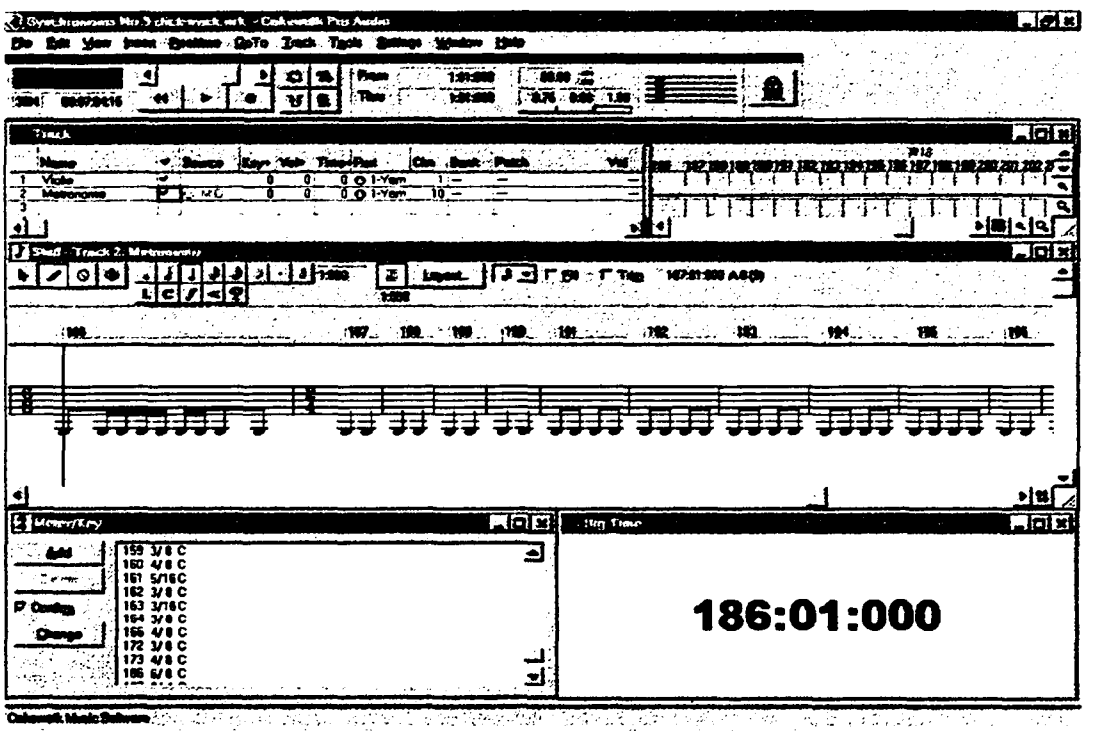
modifications on a sequencer can be made as not to effect any of the structural relationships, including pitch or rhythm, it provides the perfect means for effective slow-motion practice. This allows the performer to utilize, what is commonly termed in traditional music, a *practice tempo*.

Click-Track

The most basic representation of a click-track designed strictly for rhythm is that which simply provides the fundamental beat pattern. Thus, in common time one could program the sequencer to beat four quarter notes, and then six eighth notes as the meter shifted to six-eight time. However, the discernment of complex figures may necessitate a more creative approach towards the realization of a click-track. Since different performers may perceive rhythmic gestures in different ways, the construction of a useful rhythm guide is by no means limited to a universal scheme or generic beat pattern. As well, simply importing the actual rhythm of the violin part as it appears in the score might not provide the

performer with a complete understanding of the bigger picture, such as the relationship of the violin to the tape part.

Example #17: click-track of Synchronisms No.9
(using Cakewalk ProAudio sequencing program)



An effective, *individualized* click-track is certainly based on traditional principles of rhythmic

training. Such devices include the use of agogic or main-beat accents, the subdivision of beats into smaller units, and the local incorporation of irregular groupings, as stated earlier. If the piece contains many complex shifts of meter and is constantly introducing new rhythmic figures, from measure to measure, for example, it is most advisable to focus on achieving proficiency in this area prior to addressing the mechanical issues of the instrument, itself. Example #17 illustrates a possible click-track for Davidovsky's *Synchronisms No.9*, created using the ***Cakewalk ProAudio*** sequencing program.

One element which is not indicated in the visual representation of the click-track is the greater intensity of sound programmed into the first beat of each measure. Obviously, the intention here is to reinforce the down beat of every measure in order to assist in avoiding any local confusion. Also, though I personally did not choose to manipulate timbre, there exists the possibility of selecting different sounds and volume levels for each beat or subdivision. Other

features include the incorporation of precise tempo changes, accelerandi and ritards, and multiple layers of various types of click-tracks. The latter might be useful when desiring a rough impression of a complex work, lacking the aid of a composer or a recording; it is possible to program, to a certain degree, a simulation of the violin and tape parts along with a rhythmic click-track. Each individual track may then be isolated one or two at a time for further study or clarification.

Miscellaneous Comments

In some cases, composers construct a practice tape containing a simulation of the violin playing along with the tape part, such as *AM Fugue*. In other cases, as with the ***Southwestern Ghosttown Fantasy*** (1996) of **Justin Saragoza**, a MIDI sequencer is used to compose the work, thus, providing the performer with first-hand access to the actual music, for preparatory reasons. Since there are a variety of mediums at the disposal of the modern day electro-acoustic music composer,

including diverse hardware and software, it is up to the teacher or performer to best decide how to organize an effective curriculum of training, dependent upon the nature of each individual composition.

Suggestions for Composers

It is imperative for composers of electro-acoustic music, specifically those who desire to write for tape and live performer, to recognize the magnitude of compositional skills needed for a successful merger of these contrasting mediums. Since the composer is held directly accountable for the precision of the tape realization, there can be no oversight of any kind. A piece for tape and performer appears to suffer in proportion to the composer's lack of instrumental understanding and studio experience. A composer can avoid unconvincing results by effective study and preparation prior to the actual physical process of composition.

The most important consideration when writing for such diverse mediums is to assess and compare the capabilities of each medium, with respect to one another. Practically speaking, this means that an electronic composer should begin from the perspective of an *acoustic* instrument, since this would typically represent the area of less familiarity and greater limitation. Thus, it is prudent for a composer to research far beyond the fundamental knowledge of the selected instrument(s). Besides the rudimentary awareness of pitch and dynamic range, as well as the recognition of feasible durational limits, it is crucial to understand the various other special, unique capabilities of the instrument(s).

In order to fully explore these capabilities it is in the best interest of the composer to collaborate closely with a live performer. Unless the composer is also an adept performer, or has had extensive training on the instrument, the presence of an experienced player is an invaluable aid to the discovery of new possibilities and realistic limitations. Such ideas

include the *palette* of timbres and the exploration of special or atypical effects.

Visual Imagery

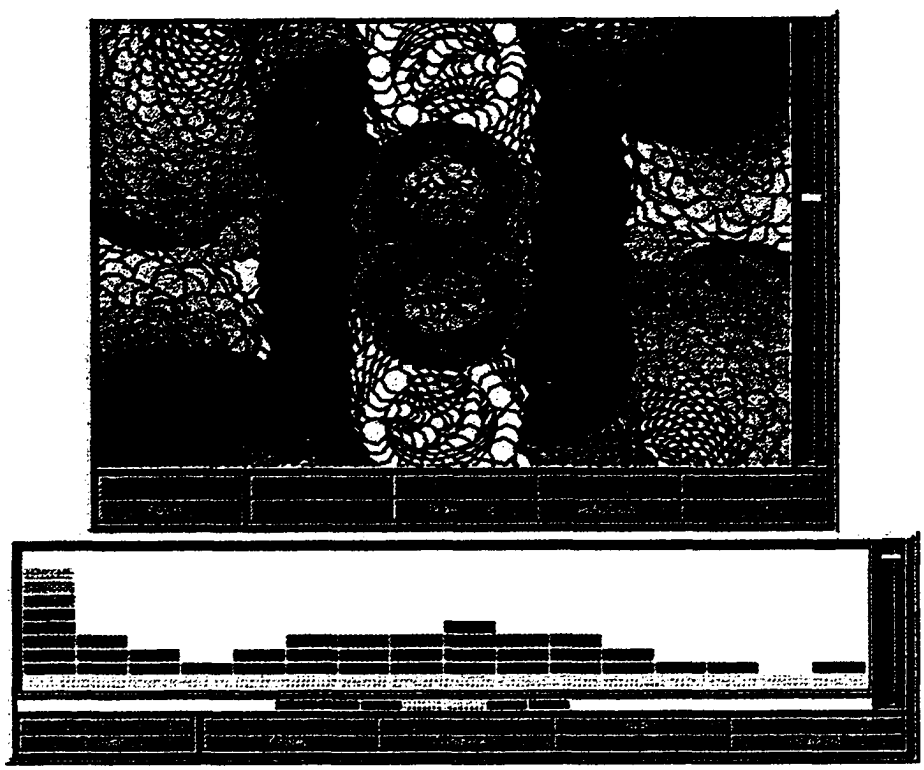
One final miscellaneous category of electro-acoustic synchronization deals with that of visual imagery, such as dance, light display, or computer graphics. Due to the abstract nature of electronic composition, the use of a contrasting stimulus, one which reflects the character of the music, can serve to enhance audience response. Appropriate use of such visuals, however, mandates that the music itself is not overshadowed or obscured. Obviously, discretion plays a major role in the determination of effective complementary stimuli. Pieces that are less abstract or more static may be hindered by excessive use of additional media. Thus, the process of incorporating a coexisting stimulus must be well thought out and representative of the music.

Computer Graphics

Constant changes of timbral color and motion makes *Synchronisms No.9* well suited for the use of abstract computer imagery. However, the present trend of computer graphic design begins with the construction of visual models, followed by the subsequent composition of sound or music as an enhancement. Thus, the notion of adding visuals to an existing musical work is reverse to the current mode of operation in the field of computer graphics. However, since both sound and imagery are subject to similar methods of spectral analysis, either one may be fabricated, to a certain degree, out of the other.

Spectrum analyzers, as well as other innovative software products, are currently very accessible, due to the rapid-paced growth of computer technology, combined with the marketing efficiency of the world wide web. Example #18 shows a software package that incorporates both an audio spectrum analyzer (bottom) with a synchronized graphics program, in the form of a PC screen saver (top). This kind of setup is very

Example #18: Synthesoft's 'Psychedelic' screen saver and 'CD Spectrum Pro' audio spectrum analyzer



effective in coordinating abstract computer imagery to a work, such as *Synchronisms No.9*. The user is able to select from a series of *visual modules*, which, in turn, react to the real-time analysis of the audio source. The audio may be inputted in various formats, including

audio CD, microphone, or external device, such as a DAT player. An effective feature of this particular software duo is the ability to select the *order* and *timing* of chosen modules, while the interplay between the visual playlist and the music is left to the precision of computer technology.

Summary

This treatise has presented an historical overview of electro-acoustic music, including the development of electronic instruments and related technology, as well as the evolution of compositional technique. Moreover, it has presented an insight into the effective preparation of *Synchronisms No.9*, an exemplary electro-acoustic work composed for violin and tape, by Mario Davidovsky. The complexity of this work provides for an extensive exploration of violin mechanics, as well as a necessary study of procedures for the crucial synchronization of the violinist with a strict,

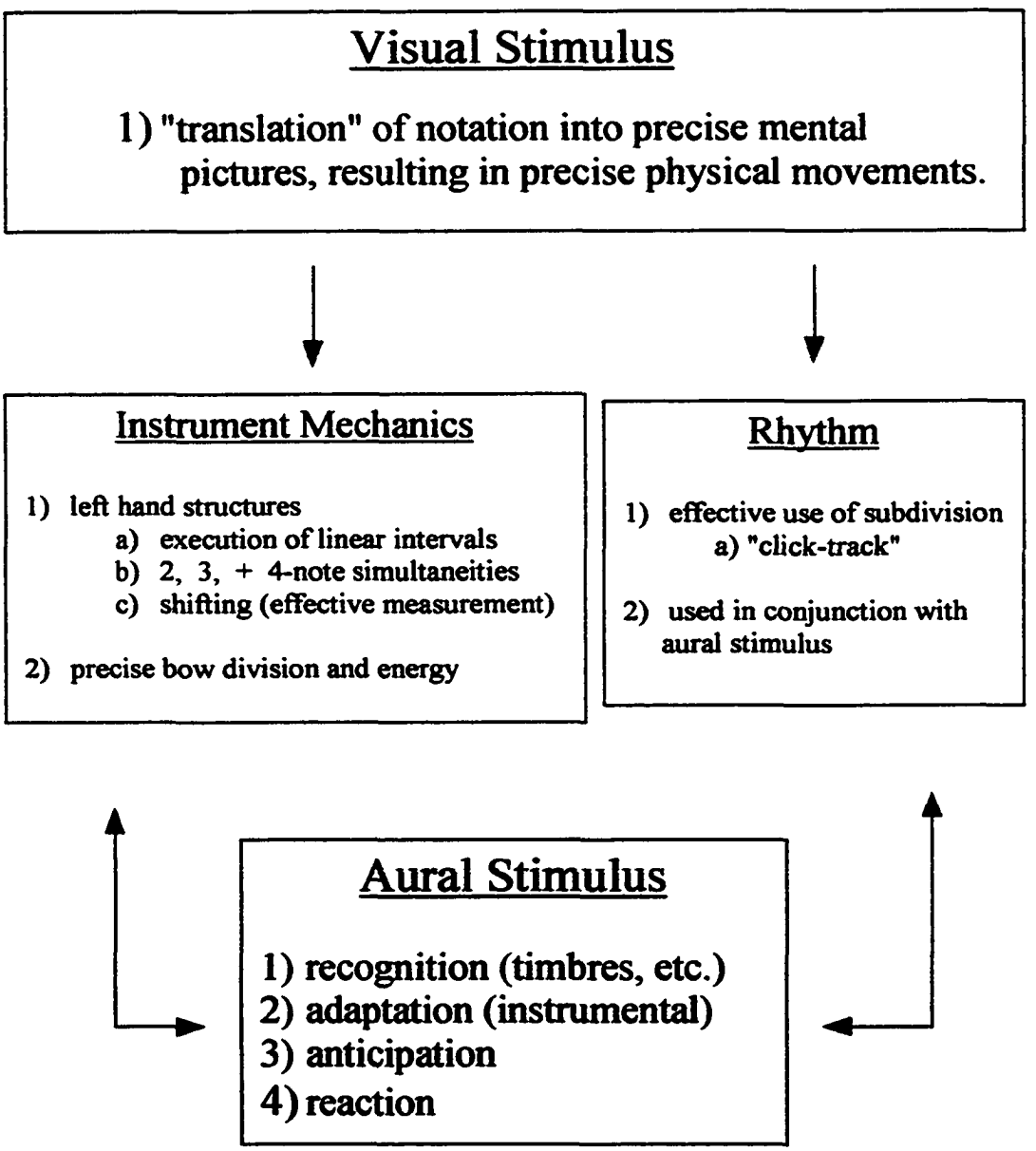
inflexible *tape performer*. The technical aspect of performance is made manifest by a philosophy of preparation which advocates the translation of second-hand information, such as notation, into usable, first-hand procedures. Also, the successful interplay between violin and tape requires both local analysis, and the development of a larger sense of physical or psychological time.

The treatise also avers the validity and importance of the electro-acoustic genre, in general, as an effective modern-day compositional resource in the United States. As exemplified by Davidovsky's *Synchronisms* series, this music firstly provides an excellent forum for the further exploration or rediscovery of bona-fide practice procedures, such as those presented in this treatise. Secondly, electro-acoustic music has vast potential to appeal to the modern society, being that it is a product of current, popular technological trends. Such trends encompass the full spectrum of computer-related multimedia, including virtual and abstract imagery, as well as

sound production and manipulation. Lastly, electro-acoustic music promotes a much needed collaboration between composer and performer. Obviously, this serves to strengthen the ties of various *camps* of musicians, promoting a unification of efforts. At present, this pooling of resources is crucial to the sustenance and growth of musical opportunities in the United States.

Appendix

Summary of Approach to Synchronisms No.9
(a complete preparatory experience for the performer)



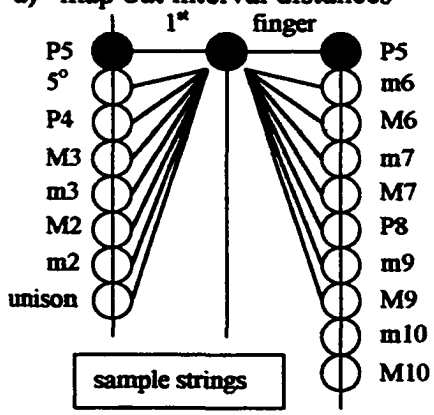
Synchronisms No.9:

Various Methods of Preparation

Clear Mental Picture	→	Proper Physical "Feel"	→	Correct Execution

1) Interval Warm-up

a) map out interval distances



2) Shift Distances Warm-up

a) map out shift intervals
   i) individual fingers on one string
   ii) finger combinations
      - single string
      - different strings

3) "Event" Practice

a) individual attention to each note or note groups
(1, 2, 3, 4-note stops - harmonics - L.H. pizz., etc.)
i) perfect execution of each and every event
ii) time is NOT a factor
iii) clarification of miscellaneous instructions, etc.

b) individual attention to shift distances

4) "Click-Track" Rhythmic Training with MIDI sequencer (optional)

a) initial procedure
i) input entire metrical structure (as shown in score)
ii) input basic metronomic values for each measure
iii) subdivide measures, as desired, for rhythmic clarity

b) verbalize piece
i) choose (local) sectional goals
ii) slow down click-track, proportionally, to achieve rhythmic precision between events, etc.

5) Practice Tape

a) choose local and sectional goals (repetition)
b) internalize violin / tape interplay relationships
- (simultaneous, anticipate, react)

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VITA

Andrew Rafael Perea was born in Brooklyn, New York on December 15, 1964, the son of Grace Padovani and Eulalio Rafael Perea. After completing his studies at Walt Whitman High School, Huntington Station, New York, in 1982, he entered the Aaron Copland School of Music at Queens College in Flushing, New York. He received the degree of Bachelor of Music from Queens College in June 1987. In the spring of 1988 he relocated to Tampa, Florida, where he began his studies at the University of South Florida. He received his Master of Music from the University of South Florida in May 1990. After four years of professional performance experience, including one year of teaching in the public school system, he applied and was accepted into the Doctor of Musical Arts program at the University of Texas at Austin, where he studied from the fall of 1994

through the summer of 1998. Upon successful completion of his dissertation, which included this treatise, he was awarded the Doctor of Musical Arts degree from the University of Texas at Austin.

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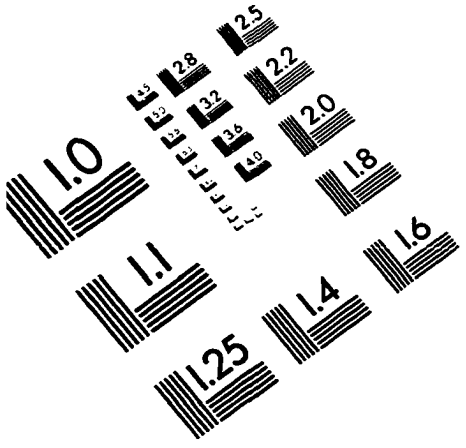
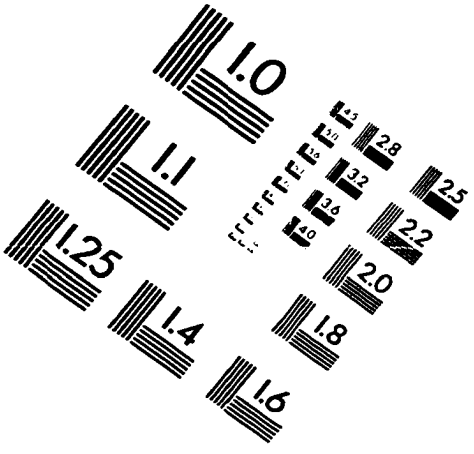
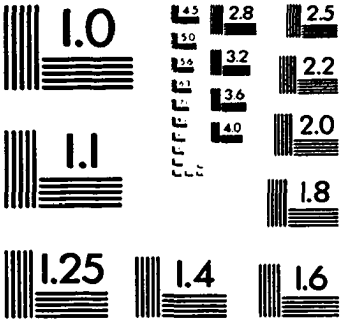
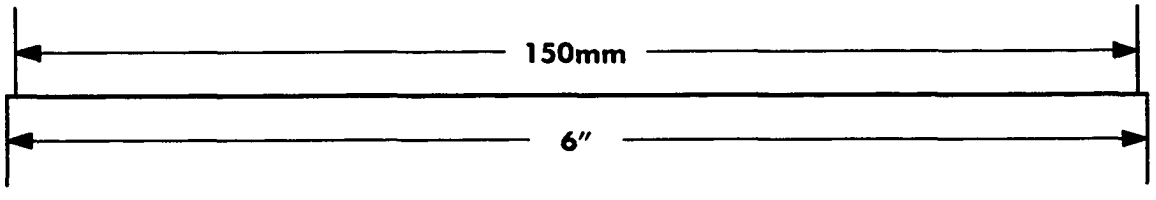
This treatise was typed by the author.

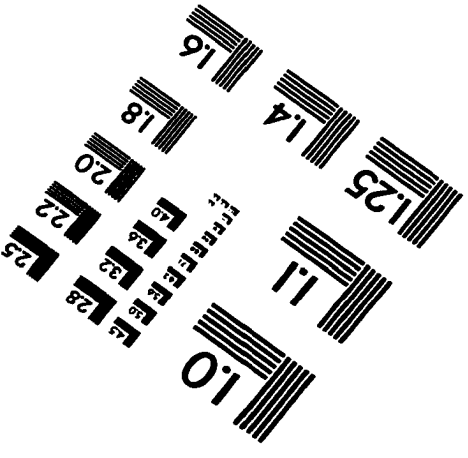
IMAGE EVALUATION TEST TARGET (QA-3)

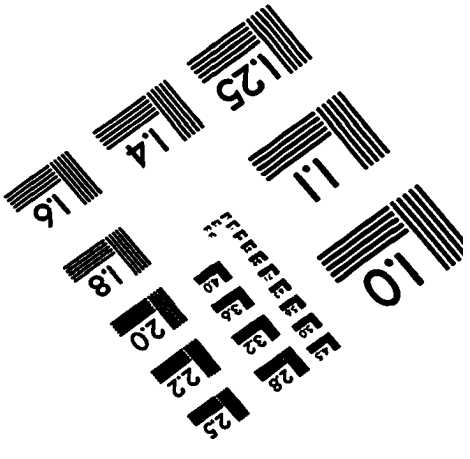












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