MUC 4313/5315

Reading Notes:
Chadabe - **Electric Sound**

Sample Exams

Moog Patch Sheet

Project Critique Form

Listening List

Truax - **Letter To A 25-Year Old Electroacoustic Composer**

Fall 2003

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Chapter 1, The Early Instruments

What we want is an instrument that will give us a continuous sound at any pitch. The composer and the electrician will have to labor together to get it. (Edgard Varèse, 1922)

History of Music Technology

27th cent. B.C.	- Chinese scales
6th cent. B.C.	- Pythagoras, relationship of pitch intervals to numerical frequency ratios (2:1 = 8ve)
2nd cent. C.E.	- Ptolemy, scale-like Ptolemaic sequence
16 cent. C.E.	- de Salinas, mean tone temperament
17th cent. C.E.	- Schnitger, equal temperament

Instruments

Archicembalo (Vicentino, 17th cent. C.E.) 31 tones/8ve
Clavecin electrique (La Borde, 18th cent. C.E.) keyboard control of static charged carillon clappers

Futurist Movement

L'Arte dei Rumori (Russolo, 1913), description of futurist mechanical orchestra
Intonarumori, boxes with hand cranked "noises"
Gran concerto futuristica, orchestra of 18 members, performance group of futurist "noises"

Musical Telegraph (Gray, 1874)
Singing Arc (Duddell, 1899)

Thaddeus Cahill

Art of and Apparatus for Generating and Distributing Music Electronically (1897)
Telharmonium (1898)
New York Cahill Telharmonic Company declared bankruptcy (1914)
Electrical Means for Producing Musical Notes (De Forest, 1915), using an audion as oscillator, more cost effective

Leon Theremin

Aetherphone (1920) a.k.a. Theremin
RCA acquired license to manufacture Theremin (1928), made only 200
Airphonic Suite for RCA Theremin and Orchestra (Schillinger, 1929)
Terpsitone (early 1930s), musical floor
Bugging device for KGB (1947)

Sphärophon (Mager 1926), like theremin but with discrete pitches
Dynaphone (Betrand, 1928)
Trautonium (Trautwein, 1928)
Concerto for Solo Trautonium and Orchestra (Hindemith, 1930)
Ondes Martenot (Martenot, 1928)
Written for by Messiaen, Milhaud, Honegger, Ibert, Jolivet, Varèse, Jarre, and Boulez
Hammond Organ (Hammond, 1929)
Electronic Sackbut (Le Caine, 1948)
Mixturtrautonium (Sala, 1948), polyphonic subtractive synthesis instrument using amplified spun gut strings
Sound effects for Hitchcock's The Birds
Five Improvisations on Magnetic Tape (1961)
RCA Mark II Electronic Music Synthesizer (Olson, 1957)
Princeton arrival (1959)
Written for by Wourinen, Ussachevsky, and Babbitt

Milton Babbitt

Composition for Synthesizer (1961), Vision and Prayer (1961), Philomel (1963), Ensembles for Synthesizer (1964), and Phonemena (sop. & pno. ver. 1969, sop. & synth. ver. 1975)

Free Music Machine (Grainger and Cross, mid-1950s)

Chapter 2, The Great Opening Up of Music to All Sounds

Colors are not used because they are true to nature but because they are necessary to the particular picture (Wassily Kandinsky)

LINEARITY OF ART HISTORY (Newtonian Period, ca. 1600-1900)
Newton: Absolute Time

20TH-CENTURY ASYNCHRONISITY
Einstein: Special Theory, multiple clocks
Apollinaire: Lundi Rue Christine (1913), poetry with juxtaposition of unrelated phrases and fragments
Busoni, "Music was born free; and to win freedom is its destiny."
Stravinsky, Le Sacre du Printemps (1913)
Ives, Putman's Camp (1914)

Found Sound
- Respighi, Pines of Rome (1924), recorded nightingales
- Antheil, Ballet Mécanique (1926), airplane engine on stage

John Cage, first composer to use found sounds
- Had affinity for Duchamp's "readymades"
- Construction in Metal (1939)

> "I felt the need of some structural means adequate to composing for percussion. This led me eventually to a basic reexamination of the physical nature of sound. Sounds, including noises, it seemed to me, had four characteristics (pitch, loudness, timbre and duration), while silence had only one (duration). I therefore devised a rhythmic structure based on the duration, not of notes, but of spaces of time…" [Cage quote pg. 25]

- 4'33", define parts before putting in sounds
- Imaginary Landscapes, collection of works with different sounds inserted (1, phonographs; 3, tin cans and oscillators; 4, 12 radios; 5, 42 LPs)

> "I believe that the use of noise to make music will continue and increase until we reach a music produced through the aid of electrical instruments which will make available for musical purposes any and all sounds that can be heard…whereas, in the past, the point of disagreement had been between dissonance and consonance, it will be, in the immediate future, between noise and so-called musical sounds." [Cage quote pg. 26]

Pierre Schaeffer (ORTF)
- Etude aux Chemins de Fer (1948), Railroad Studies
- Coined the term "musique concrète"
- Concert de Bruit (Concert of Noise), radio broadcast
- w/Pierre Henry, Symphonie pour un Homme Seul (1950), locked groove disc

Edison cylinder (1877)
Gramophone (1887)
Magnetic recording proposed (1888)
Telegraphone (1898), wire recorder
Blattnerphone (1925), steel ribbon recorder
Dailygraph (1925), cartridge wire recorder
Powdered magnetic material (1927)
Optical recording (1930s)
Magnetophone (1935), plastic tape
- Improvement of frequency response to 15 kHz at 30 ips
- Became a spoil of war and examples shipped to USA (1945)

3M black oxide coating (early 1947)

3M red oxide coating (late 1947)
Stereo tape machine (1949)
pupitre d'espace (1951), sound distribution system
Photogène (1951), variable speed tape recorder
Morphophone (1951), multiple head tape recorder

Groupe de Recherche de Musique Concrète (1951)
Schaeffer (Founder), Hodier, Boulez, Messiaen, Stockhausen, Philippot, Henry, Milhaud, Varèse, Barraqué

Pierre Henry
Orphée (1951), Le Voile D'Orphée (1953), Studio Apsome (1959), Variation pour une Porte et un Soupir (1963)

Groupe de Recherche Musicales (1958)
Ferrari, Mâche, Philippot, Xenakis, Schaeffer

Iannis Xenakis
Diamorphoses (1957), Concret P.H. (1958), Orient-Occident (1960), Bohor (1962)

A la recherche d'une musique concrète (Schaeffer, 1952), first "how-to" book of musique concrète
Traité des Objects Musicaux (Schaeffer, 1966), essays on musique concrète

NWDR (Cologne, Germany, 1952)
Meyer-Eppler, Beyer, Eimert (1st Director), Goeyvaerts, Koenig, Stockhausen, and Maderna

Bruno Maderna
Musica du Due Dimensioni (1952), flute, percussion, and tape
"electronische musik," an extension of serialism

> "I, in turn, assert that any musician who has not experienced—I don not say understood, but in all exactness, experienced—the necessity for serialism it *useless.*" [Boulez quote pg. 37]

Serialism

> "It is certain that no means of musical control could have been established over electronic material had it not been for the revolutionary thought of Anton Webern… Alone among the twelve-tone composers, Anton Webern conceived the row non-subjectively… In his work, for the first time, we see the beginnings of three-dimensional row technique—of what, in shore, we know as serial technique… everything, to the last element of the single note, is subjected to serial permutation… This electronic music is not 'another' music, but is serial music…Talk of 'humanized' electronic sound may be left to unimaginative instrument makers." [Eimert quote pg. 37]

Karlheinz Stockhausen
Studie I (1953), Studie II (1954), Gesang der Jünglinge (1956), Kontakte (1960), Telemusik (1966), Hymnen (1967)

> "In my *Gesang der Jünglinge*, I attempted to form the direction and movement of sound in space, and to make them accessible as a new dimension for musical experience. The work was composed for five groups of loudspeakers, which should be placed around the listeners in the hall. From which side, by how many loudspeakers at once, whether with rotation to left or right, whether motionless or moving—*how* the sounds and sound-groups should be projected into space: all this is decisive for the comprehension of this work. The first performance took place on May 30th, 1956, in the main broadcasting studio at Cologne Radio Station. Today there are already quite a number of electronic spatial compositions… " [Stockhausen quote pg. 40]

Jikken Kobo (1951), experimental workshop
Yuasa, Takemitsu, Suzuki, Fukushima

NHK (Tokyo, Japan, 1954)

Mayuzumi (ORTF), Shibata, Maroi (NWDR), Ichiyanagi, Yuasa

Joji Yuasa
Projection Esemplastic (1964), Aoi no Ue (1961)

MOMA Concert (Oct. 28, 1952), first electronic music concert in the USA
Vladimir Ussachevsky Sonic Contours; Otto Luening Low Speed, Invention, and Fantasy in Space

> "We wrote a report for the Rockefeller Foundation on the state of experimental music in Europe and the United States, including recommendations about the best program to be followed here.
> Our studio in the Ussachevsky living room was moved to my apartment. We then reported to President Kirk of Columbia University that unless we could have space on campus, our whole program would be seriously jeopardized. Soon afterwards, we were provided with suitable quarters—the charming "Charles Adams" house, located on campus at the site of the former Bloomingdale Insane Asylum… " [Luening second quote pg. 45]

Columbia University Electronic Music Studio (1955)
Columbia-Princeton Studio (1959), established with RCA Mark II Electronic Music Synthesizer
Davidovsky, El Dabh, Ussachevsky, Babbitt, Arel, Luening, and Wourinen

RAI (Italy, 1955), Studio di Fonologia Musicale
Berio (Founder), Maderna, Lietti, Pousseur, and Nono

> At that time, techniques and procedures were quite time consuming. Everything was done by cutting and splicing tape…In order to create certain effects, some sounds had to be copied sixty, seventy, and eighty times, and then spliced together. Then these tapes had to be copies further at different speeds in order to achieve new sound qualities more or less related to Cathy Berberian's original delivery of the text. I was interested in constant and controlled transformation from discontinuous to continuous patterns, from periodic to nonperiodic events, from sound to noise, from perceived words, to perceived musical structures, and from syllabic to phonetic view of the text…I didn't surrender to the difficulties…It's surprising now to think that I spent several months of my life cutting tape while today I could achieve many of the same results in much less time by using a computer." [Berio quote pg. 50]

Bruno Maderna
Continuo (1958), Invenzione su una Voce (1960), Serenata (1961), Le Rire (1962), Tempo Libero (1972)

Luigi Nono
Omaggio a Vedova (1960), La Fabbrica Illuminata (1964), Ricordati Cosa Ti Hanno Fatto in Auschwitz (1966), Non Consumiano Marx (1969)

Tristram Cary (independent studio), film/tv music
The Lady Killers (1955), The Little Island (1958), BBC tv series Doctor Who

Louis and Bebe Barron, film music
Forbidden Planet (1956)

John Cage
Williams Mix (1952)

Harmonielehre (Schoenberg, 1911), "Klangfarbenmelodie" - "sound color melody"

Kandinsky, "Colors are not used because they are true to nature but because they are necessary to the particular picture." (1912)

Varèse, "Our musical alphabet must be enriched…we also need new instruments very badly…"

Brussels World Fair (1958), Xenakis and Le Corbusier pavilion

Edgard Varèse Poème Electronique
Iannis Xenakis Concert P.H.

Chapter 3, Expansion of the Tape Music Idea

Electrical instruments…will make available for musical purposes any and all sounds that can be heard (John Cage, 1961)

Estudio de Fonologia Musical (University of Buenos Aires, 1958)
Francisco Kröpfl
Ejericicio de Impulsos (1960), Dialogos I, and Dialogos II

CLAEM (Centro Latinoamericano de Altos Estudios Musicales, Instituto De Tella, Buenos Aires, 1963)
Davidovsky (Founder), Kröpfl (Director, 1967), Lanza, Kusnir, Marazano, Martinez, Caryevschi
Became CICMAT (Centro de Investigaziones en Communication Massiva, Artes, y Technologia, 1971)

1959 University of Toronto received first multi-track tape recorder built by Hugh Le Caine

> "When I came in, there were two Multi-Track tape Recorders, the proto-type, and an update. In the updated version, you could play sixteen channels of pre-recorded sound through a sixteen-input mixer which was controlled by sixteen tough-sensitive keys. It was a performance instrument. The National Research Council had been interested in commercializing it if it looked better and if it could be debugged, so Hugh had done a dress up of the original prototype. But by the time we had it refined, no one was interested in it. It would have been a very expensive instrument for its time—the original projections were between $25,000 and $30,000" [Ciamaga quote pg. 64]

Radiophonic Workshop (BBC, 1958)
"applied electronic music" (Hodgson, 1962)

Swedish Radio
Oyvind Fahlström, Fåglar i Sverige (1963)
Lars-Gunnar Bodin, Cybo I (1967)

Fylkingen
Sten Hanson, Che (1968), How Are You (1969), fnarp(e) (1970), Opis! (1971), and Ouhm (1973)
Becomes leader of "text-sound group"

Kontakte (Stockhausen, 1960), addition of live element
Times Five (Brown, 1963), multiply instruments
I of IV (Oliveros, 1966), performance onto tape

> "I wanted to bypass editing, if I could, and work in a way that was similar to performance…As I was making I of IV, I was also listening to it. At one point in the piece there's a rather climactic scream-like melody that sweeps through most of the audible range. When that started coming out, I didn't expect it; it was incredible and very delightful. I was laughing and was amazed at that particular moment…" [Oliveros quote pg. 78]

Animus I (Druckman, 1966), competition with tape trombone
L's G.A. (Martirano, 1968), for "gas masked politico, helium bomb, a triple projection film and tape"
HPSCHD (cage, 1969), simultaneous yet unsynchronized, non-interactive performances; seven harpsichords at different tempos with Hiller's 51 tapes
I Am Sitting in a Room (Lucier, 1969), the room as sound modifier/(re)synthesizer
Synchronisms #6 (Davidovsky, 1970), piano and tape makes piano "larger"
Acousmonium (François Bayle, 1974), loud speaker orchestra
MAP (Foss, 1971), game
Yo-In (Jean-Claude Eloy, 1980), flexible collection of tapes to mix with live sounds

Chapter 4, Out of the Studios

It is by rules and compasses that the Greeks discovered geometry—
musicians might do well to be inspired by their example (Pierre Schaeffer, 1960)

Cartridge Music (Cage, 1960), "to make electronic music live"

Karlheinz Stockhausen
- Mikrophonie I (1964), Mixtur (1964), Mikrophonie II (1965), Prozession (1967), Stimmung (1968), Aus den Sieben Tagen (1968), and Mantra (1970)
- Electronic transformation of acoustic sound

"Sonics I", concert by Sender, Oliveros, Riley, and Winsor

San Francisco Tape Music Center (incorporated 1962)
- Bridging conflict between electronic and concrète by calling it "tape music"
- SFTMC's equipment went to Mills College for fiscal management of the Rockefeller grant ($200,000)

Once Group (Ashley and Mumma, 1961)
- Wolfman (Ashley, 1964)
- Hornpipe (Mumma, 1967)

> The soloist seats himself comfortably near the differential amplifier, and the assistant begins the procedure of applying the electrodes to the soloist's head. This operation involves cleaning the scalp with alcohol, applying special conducting electrode paste and gauze pads to secure the electrodes, measuring the electrical resistance between the electrodes (which should be below 10,000 ohms), and adjusting the gain and DC balance of the differential amplifier. The procedure takes several minutes to complete, generally a time of remarkable effect upon the audience…the situation is both ambiguous and dynamic. This period of time, before the first tapped brain-waves are directed to their resonant instruments, is really quite mysterious. After the sounds have begun, one come to recognize the coincidence of the soloist opening his eyes with the stopping of the alpha-articulated sounds." [Mumma quote pg. 96]

- Music for Solo a Performer (Lucier, 1965)

> I had made the acquaintance of Edmond Dewan, a very imaginative physicist who was on the faculty at Brandeis but who was then working for the Air Force doing experiments with brain waves. They thought that certain pilots who were prone to epilepsy were blacking out when the speed fo the spinning propellers got to a crucial point…When the sunlight would shine through the spinning props, it would lock onto something visual in the brain of the pilot…
>
> Dewan described to me this phenomenon that had to do with visualization, that by putting yourself in a non-visual state…you could release the potential of the alpha that is in your head. It's a very small amount, but it would become perceptible, at least to an amplifier… Alpha itself is below audibility; it's too low to hear as pitch, but that high energy, those bursts of alpha, would come bumping through the loudspeakers, making the grille cloth on the speakers bump, and I got the idea of using that enerby to compulte the loudspeakers to instruments. I used gongs, tympani, bass drums…
>
> Most people thought the material was too simple…but I finally did what I thought was the most honest thing. I tried to be very accurate about what the piece really meant: one person, alone, sitting very, very quietly, releasing a flood of energy which permeates the concert space. And to me, that was a beautiful idea…" [Lucier quote pg. 97]

Dance
- Merce Cunningham
  - Symphonie pour un Homme Seul (Henry and Schaeffer, 1952), Rainforest (Tudor, 1958), Walkaround Time (Behrman, 1967)

Sonic Arts Group/Sonic Arts Union (1966)

Behrman, Mumma, Ashley and Lucier

Musica Electronica Viva, a.k.a. MEV (1966)
Rzewski, Curran, Teitelbaum, Bryant, Phetteplace, Plantamura, Vandor, Lacy, and Lavine
Group improvisation, Spacecraft (1967), Zuppa (1968), and Sound Pool (1969)

Experiments in Art and Technology, a.k.a. EAT (1966)
"9 Evenings: Theater and Engineering"
Variations VII (Cage)
Brandoneon! (Brandoneon Factorial) (Tudor)

Other Festivals
"First Festival of Live Electronic Music" (Mills College, 1967)
"Cross Talk Intermedia Festival" (Tokyo, 1969)

Chapter 5, Computer Music

It turns out that computer music is a very social activity—
the inventors worked in teams, interacting with one another,
and it continues that way (Larry Austin)

FIRST COMPUTER GENERATED SOUNDS

Bell Telephone Laboratories (Murray Hill, NJ, 1957)
- Max Mathews
  - Tests to judge telephone sound quality used "converter" to put sound into/out of a computer
  - John Pierce, as Director of Communication Sciences Division supported Mathew's research (coined the term "transistor" in 1948)
  - Music I (1957), first sound-generating computer program
    - In the Silver Scale (Guttman, linguist and acoustician at Bell Labs), first computer music piece; used altered diatonic scale
    - Only one voice, one waveform (triangle wave), no envelope control
  - Music II (1958), four voices, arbitrary waveform, and wavetables
  - Music III (1960), "when all things came together" (Mathews)
    - Modularity (unit generators) for Orchestras
    - Score
  - "Music from Mathematics" (1960), recording from Bell Labs
    - Aaron Copland, "The implications are dizzying and, if I were twenty, I would be really concerned at the variety of possibilities suggested."
  - Pierce visited the University of Illinois (1961) where he visited Hiller, Isaacson, Partch, and Tenney; he hired Tenney to officially do research in psychoacoustics, but really to do computer music.

  - James Tenney (Bell Labs, 1961-64)
    - Analog #1, Noise Study (1961)
    - PLF 2, a composing program
      - Four Stochastic Studies (1962) and Dialogue (1963)

  - Music IV (Miller and Mathews, 1962: improvements Howe and Winham, Music IV-B)
  - "The Digital Computer as a Musical Instrument." *Science* (Mathews, 1963)

> "There are no theoretical limitations to the performance of the computer as a source of musical sounds, in contrast to the performance of ordinary instruments. At present, the range of computer music is limited principally by cost and by our knowledge of psychoacoustics…Computer music appears to be very promising technically. However, the method will become significant only if it is used by serious composers. At present, our goal is to interest and educate such musicians in its use…"[Mathews quote pg. 110]

  - Risset does research at Bell Labs (1964)
  - Music IV-BF (Howe, 1967), first software synthesis system (SWSS) to be machine independent (written in FORTRAN)
  - Music V (Mathews, Moore, Risset, and Miller, 1968), definitive version of Music-*n* series of SWSS
    - F. Richard Moore, "We used to send the Music V program out in two full boxes of punched cards, about 3500 cards, and a letter saying, 'Good Luck!'"
  - Non-intuitive interface and lack of real-time interaction

John Chowning
- SAIL (Stanford Artificial Intelligence Laboratory)
  - Music IV running (1964) for research on sounds traveling through space
  - Research leads to discovery of musical application for frequency modulation (1967)
  - "The Simulation of Moving Sound Sources," *Journal of the Audio Engineering Society*, vol. 20, no. 6 (1971)
  - First summer workshops in computer music (1969)
  - Continued research in FM (1971)

"The Synthesis of Complex Audio Spectra by Means of Frequency Modulation," *Journal of the Audio Engineering Society*, vol. 21, no. 7 (1974)
American companies not interested in FM
Yamaha licenses FM (1974)
CCRMA (Center for Computer Research in Music and Acoustics), form with co-director Leland Smith (1975)
John Pierce joins as research professor (1983)
Max Mathews joins as research professor (1987)
Patent for FM issued (1977)
Samson Box (Sampson, 1977), delivered
Researchers included Loy, Jaffe, McNabb, and Schottstaedt
Functioned as real-time Music IV
Used until 1989
Sabelithe (1971) and Turenas (1972), spacialization
Stria (1977), Golden Section for relations within sound timbre (partials) and between sounds

Jean-Claude Risset
"Computer Study of Trumpet Tones," Bell Labs (1966)
"On the Analysis, the Synthesis and the perception of Sounds, Studied with the Aid of Computers," dissertation (1967)
Computer Music Group at the Institut d'Electronique Fondamental (Orsay, France)
First computer music implementation, Music V, in Europe (Risset, 1969)
"An Introductory Catalog of Computer Synthesizer Sounds," Bell Labs (1969)
Becomes Music Department Head at the Centre Universitaire de Marseille-Luminy (1971)
Dialogues (1975), for four instruments and tape
Becomes the "Responsible" for the computer department at IRCAM (1975)
Accepted a post at the University of Aix-Marseille (1979)
Appointed to CNTS (Centre National de la Recherche Scientifique, 1985)
Suite for Computer Little Boy (1968) and Inharmonique (1977), unique timbres
Sud (1985), bridging the natural and synthesized timbres

IRCAM (Institut de Recherche et Coordination Acoustique Musique, Paris, France, 1970)
Music research institute formed as part of the Centre National d'Art Contemporain
Created and directed by Pierre Boulez
New facility completed as part of the new Centre Pompidou (1977)
Mathews appointed as scientific advisor (1974)
Espace de Projection, adaptable black-box performance space
Five departments: computer, performance, electronic music, pedagogy, "diagonal" (to keep all the others cooperating)
CHANT (Rodet, 1978), physical model of singing
FORMES (Rodet, et al, 1981), control of hierarchical musical processes
Chreode (Barrière, 1983)

Barry Vercoe
Music 360 (1968-71)
Taught at Yale (1970-71)
MIT (1971)
Digital Equipment Corporation gives Vercoe a PDP-11 mini-computer
Music 11 (developed for the PDP-11, 1973), two modes of control: 1) musical keyboard entry for simple timbre verification of notes and rhythms in real-time, and 2) full fidelity Music 11 mode not in real-time
Synapse (1976), for viola and computer

CARL (Computer Audio Research Laboratory, University of California San Diego, 1979)
F. Richard Moore (Director)

> The question that interested me was whether to work for an industrial research lab where we were unofficial but had money, or to go to a university where we were official but had not money. In industry, you're guaranteed to make progress but not necessarily in a direction of your choosing. In a

> university, you're guaranteed that you can choose your direction, but you're not necessarily going to make any progress" [Moore quote pg. 122]

Last significant Music-*n* installation, cmusic (VAX)

Charles Dodge
- Analysis-synthesis approach to speech synthesis
- Speech Songs (1972), The Story of Our Lives (1974), In Celebration (1975), Cascando (1977), Any Resemblance Is Purely Coincidental (1978), and Roundalay (1985)

"Generality" of SWSS

> "There was no limit on the complexity of the sound that could be produced. If you wanted to produce 10,000 sine waves all at the same time, you could do that, no problem. In fact, it gave you time to get a cup of coffee while you waited for it to compute. Another thing is that it very much lent itself to experimentation. It is far easier to prototype a software unit that to prototype a hardware unit, and it doesn't require anything near the technical expertise." [Moore quote pg. 127]

Institute for Music and Acoustics at the Zentrum für Kunst und Medientechnologie (Karlsruhe, Germany, 1988)
- Johannes Goebel (Director)
  - Ubersetzen über den Fluss (1988), resonant filtering of fractal noise
  - *SubBass-ProtoTone* and *Extended Tuba*, new instruments for new sounds

Dennis Smalley
- Gradual (1974), Vortex (1982), Tides (1984), Wind Chimes (1987), and Valley Flow (1992)
- Use of computer to "compose sound"

> "My musical ideas come out of the sounds themselves. I explore their characteristics. I discover. With digital techniques, for example, I can isolate fragments that the ear can't otherwise hear. So I can pick out surprising elements, and I might say, "Let's play with it," and see if it gives me something. Or I might say, "Now that's a great sound. I have to use it." Or I might think that there are qualities in there which I can harness in building a piece of music. [Smalley quote pg. 130]

SoundBall (Lockwood, 1984), spacialization via flying speaker
- Three Short Stories and an Apotheosis (Lockwood, 1985)

BEAST (Birmingham Electro-Acoustic Sound Theatre), multi-loudspeaker playback system

François Bayle
- Les Couleurs de la Nuit (1982), Son Vitesse-Lumière (1983), and Aéroformes (1984)

CTR (Centro Tempo Real, Florence, 1979)
- Berio and Di Guigno (Founders), Otto, Bernardini, Settle, and Puckette
- *TRAILS* (Tempo Reale Audio Interactive Location System), sound spacialization system to route audio signals through a multi-speaker network (MiniTRAILS, smaller system)

Curtis Roads, Clang-tint (1995)

Paul Lansky
- Six Fantasies on a Poem by Thomas Campion (1979), As It Grew Dark (1983), As If (1982), Idle Chatter (1984), just_more_idle_chatter (1987), Notjustmoreidlechatter (1988), Smalltalk (1988), The Sound of Two Hands (1990), Night Traffic (1990), Table's Clear (1992), Quakerbridge (1992), and Still Time (1994)
- Human origin of electronic sounds

Dexter Morrill
- Colgate University lab operational (1972)
- Studies (1975), Fantasy Quintet (1978), Six Dark Questions (1979), Tarr (1982), Getz Variations (1984)

Focus on works that included live performers

Trevor Wishart
Red Bird (1977), Tongues of Fire (1994)
Transformations of sounds
Formed music discussion and presentation group called “Interface” with Orton and Endrich

CDP (Composers’ Desktop Project), system for computer synthesis on Atari ST
Wishart, Orton, Endrich, Malham, Atkins, et al
First port of SWSS to personal computer

Larry Austin, “It turns out that computer music is a very social activity—the inventors worked in teams, interacting with one another, and it continues that way.”

John Pierce, “It’ Billy Klüver’s idea that ‘isn’t it wonderful that the arts will attract the assistance of a lot of engineers,’ but the real thing is that it’s amazing how many musically talented people become expert with computers.”

Chapter 6, Synthesizers

A user interface…also includes the software (Donald Buchla)

Robert Moog (rhymes with vogue)
- Articles on theremin construction: *Radio and Television News* (1954), and *Electronics World* (1961)
- Meets Herb Deutsch (then at Hofstra University) at New York State School Music Association meeting while trying to sell his theremins (1963)
- First hand-wired VCOs and a VCA by Moog (1964)
- Visited University of Toronto Electronic Music Studio (1964)
- "Electronic Music Modules," *AES Journal*, 1965; read at the 1964 meeting
- *Switched On Bach* (Carlos, 1968), popular in 1969
- "the gimmick for 1969"
- *Minimoog* (1969), first single-unit integrated synthesizer, prototype of the Model A built
  - First public concert with a *Minimoog* was by Dick Hyman at the Eastman School in 1970
  - By 1970 the company was in trouble and purchased in 1971 (William Waytena of Musonics), then Norlin in 1973; sales increased under David Van Koevering as marketing manager.
  - Production stopped in 1980 with over 12, 000 sold
- *Polymoog*, polyphonic synthesizer

Phonosynth (Ketoff, 1963-64), large studio-oriented synthesizer built for Gino Marinuzzi

Synket - *Syn*thesizer *Ket*off (Kettof, 1965), installed at the American Academy in Rome
- John Eaton
  - Songs for RPB (1965), for soprano, piano and *Synket*
  - Concert Piece for Synket and Symphony Orchestra (1967), the new *Synket* optimized for live performance commissioned by the composer
  - Myshkin (1971), opera
  - Duet (1968), for both Moog and *Synket*
- R7 - Roma 7 (mid-1960s), group of initially seven composer formed as a contemporary performance ensemble of *Synkets*, later joined by Ennio Morricone (from spaghetti western fame)

SFTMC - San Francisco Tape Music Center (1963)

> "We put an SOS out to a fire insurance company that dealt with hi-fi stores, and they called us and said that a store had burned down, and they had all the inventory…We didn't have any money, but we rented a truck to get the equipment, and we gave them a bad check thinking that we'd find the money before the check bounced. So we sold enough equipment from the inventory, intercoms basically, also microphones, and we finally got enough money to cover the check we'd given them." [Subotnick quote pg. 146]

- Donald Buchla
  - Optically Controlled Synthesizer, analysis of hand shape in an optical path; "This is the wrong way to do it"
  - Sequencer, analog automation of a set sequence of events (notes, amplitudes, filters, etc.); meant to reduce tape splicing and enhance performance
  - Pressure sensitive "keyboard"
  - All built on a $500 grant from the Rockefeller Foundation grant in 1965
  - *Series 100* (rights sold to CBS in 1969), fringe market appeal
  - *Series 200* (1971), digital oscillators
  - Series 500 (1971), very large system (16 oscillators and gating matrix)
  - *Series 300* (1972), a computer-based controller that interfaced with the *Series 200*
  - Series 400 (1978), a computer-based system including computer monitor and programming languages (Midas III, CHOPS, and Patch VI)
  - The Modular Electronic Music System
    - Morton Subotnick

> "My method was to go to work at about 8 A.M. and to work until 2 A.M. the next morning, six days a week, and I purposefully did not know what results I was after. I believed that with this new instrument, we were in a new period for composition, that the composer had the potential for being a studio artist, being composer, performer and audience all at once, conceiving the idea, creating and performing the idea, and then stepping back and being critical of the results. I wanted to explore what kind of art I would create in that new circumstance." [Subotnick quote pg. 148]

Silver Apples of the Moon (1967), Wild Bull (1968), Touch (1969), a series of compositions for recordings from Nonesuch Records
NYU from 1966-1969
California Institute for the Arts since 1969
Sidewinder (1970), Four Butterflies (1971), Until Spring (1975)
Cloudless Sulphur (1978), written for the inauguration of the new JBL speaker factory
Jacob's Room, Pt. 1 & 2 (1986)

Putney Studio (Putney, England), Peter Zinovieff
- Purchase of DEC PDP-8 with 4K of memory (1967), purchased to develop a computer sequencer
- David Cockerell built peripheral equipment
- Partita for Computer (1968), filled the hall at a January concert at Queen Elizabeth Hall
- EMS Ltd., formed with Tristram Cary and Cockerell to "make something to sell"
  - *VCS-1*, built to sell for around 50£
  - *VCS-3*, "Putney", built for U.S. market with "pin matrix patching"
  - *DK-2* keyboard
  - *Synthi A*, a.k.a. *Portabella*, portable synthesizer
  - *Synthi-100 (*1970), large sequencer-based synthesizer (256 sequencer, random voltage generator, pitch-to-voltage converter, Octave filter bank)
  - *AKS* (1971) portable synthesizer in a case with sequencer and touch-sensitive keyboard
- Hans Werner Henze
  - Glass Music (1970), Prison Song (1971), Tristan (1973)
- Harrison Britwistle
  - Four Interludes (1969), Medusa (1970), Signals (1970), Chronometer (1971), Orpheus (1976)
- Both Henze and Britwistle detached from the technology but enamored to the precise results and possibilities
- *MUSYS-3* (Grogono, 1970), computer control language for analog synthesizer modules
- *VOCOM* - Voice COMmunications (Eastty, 1973), digital filter bank for analysis and resynthesis
- Tristam Cary
  - The Pilgrims Progress (1972) and Divertimento (1973)

Electronic Arts Foundation
- Established in 1971 to acquire, preserve, and display historical instruments (Tom Rhea and David Van Koevering)

Starting in the late 1960s popular groups/artists started playing synthesizers. Artists using synthesizers included Emmerson, Lake & Palmer, Stevie Wonder, Blood, Sweat & Tears, Mothers of Invention, Todd Rundgren, Yes, Pink Floyd, Jan Hammer, John McLauglin, Billy Cobham, Herbie Hancock, Chick Corea, Roxy Music, and Brian Eno.

ARP Instruments
- Started in 1969 by Alan Pearlman
- *Model 2500*, modular synthesizer
- *Model 2600*, portable synthesizer: "blue meanie" or "blue marvin"
- Also the *Pro-Soloist*, *Odyssey*, *Axxe*, and *Omni*

Tom Oberheim
- Worked for Norlin making ring modulators and such under the Maestro brand
- Became an ARP dealer after seeing a *2600* at a NAMM show in 1971
- *DS-2*, 144-note digital sequencer; sold for $25 (1972)
- *Synthesizer Expander Module - SEM*, incorporating a digital sequencer that could be played at the same time as the keyboard

Four Voice, a modified keyboard design licensed from E-mu Systems combined with the SEM (1975)
OB-1, programmable monophonic synthesizer

Sequential Circuits (Dave Smith)
Prophet-5, fully programmable and polyphonic synthesizer with microprocessor auto-tuning (1978)

University of Toronto
Piper, digitally controlled analog synthesizer (Ciamaga and Gabura, 1965)
Increased from one to four voices
Ended in 1973 when IBM removed the computer

Bell Labs
GROOVE (Generated Realtime Operations on Voltage-controlled Equipment), digitally controlled analog synthesizer (Max Mathews-conductor program and Richard Moore-composition algorithms, 1967)
Built around a brand new Honeywell DDP224 acquired for dedicated sound research
Laurie Spiegel (1973-78)
Appalachian Grove (1974), Patchwork (174), Waves (1975), The Expanding Universe (1975), Drums (1975), Clockworks (1975), A Voyage (1976)
Emmanuel Ghent (1967-78)
Battery Park (1969), Molly Bloom's Lament (1969), Danger–High Voltage (1969), Helices (1969), Innerness (1970), Fusion (1970), Supernova (1970), Phosphones (1971)
The Honeywell computer was removed from service in December 1978

Sound Workshop (interim tape studio as EMS was being designed and built; EMS is *E*lektron*m*usik*s*tudion and not the same as EMS Ltd.), opened in 1965 by Knut Wiggen
Bodin: Toccata (1969) and Traces I (1970); Hanson: Che (1968) and How Are You (1969)

Fylkingen, Swedish new music organization

EMS (Karl Birger Blomdahl started and Knut Wiggen finished, 1970)
Took six years to complete due to unwillingness to compromise in quality, organizational issues, and politics
Originally financed by Swedish Broadcasting Corporation
Ownership of studio's equipment transferred to foundation in 1970
DEC PDP-15 obtained computer (1970)

> "The software was poor. It was complicated and painstaking to program the thing. You had to sit and write on a teletype machine and the code was coming on punched tape which you had to feed into the computer. You could be sure you'd get hundreds of error messages. There wasn't any goo editing program, so you had to try and write another punched tape." [Bodin quote pg. 167]

Tamas Ungvary
Seul (1972), basic Barrier (1973), Traum des Einsamen (1975), Les Mouvements Mousseux (1979), Ite, Missa Est (1982), and L'Aube des Flammes (1984)
Per-Olof Strömberg appointed interim director (1975)
Jon Appleton invited to be director (1976)
Lars-Gunnar Bodin became temporary director (1977) and director (1978)
Evaluation report recommended closing EMS but a large protest meeting saved and even assisted in the restart of EMS with new money (1978)

Studio for Electronic Music (a.k.a. Institute of Sonology, 1967) at the University of Utrecht
Developed *Variable Function Generator* to act like sequencer (Tempelaars, 1961)
Gottfried Michael Koenig director (1964)
Funktion Grün (1967), Funktion Gelb (1968), Funktion Orange (1968), Funktion Rot (1968), Funktion Blau (1969), Funktion Indigo (1969), Funktion Violett (1969), and Funktion Grau (1969)
DEC PDP-15 obtained (1971)
*VOSIM - VO*ice *SIM*ulation (Werner Kaegi, 1973)
*POD - PO*isson *D*istribution (Barry Truax)

University of Toronto
- *SSSP* - Structured Sound Synthesis Project (Buxton, 1978), interactive digital computer music system on a PDP-11/45/LSI-11/digital synthesizer

Dartmouth College
- Jon Appleton joins faculty and establishes studio (1967)
  - Georganna's Farewell (1975) and In Medias Res (1978)
- Bregman Studio receives large Moog modular system, etc. (1969)
- Appleton, Sydney Alonso, and Cameron Jones begin collaboration to design a digital synthesizer (1972)
- *Dartmouth Digital Synthesizer* - ear training by day/composition by night (due to CAI grant from the Sloan Foundation)
- Other compositions of note: Bilder (Images), Lars-Gunnar Bodin; Emergence, Russell Pinkston; Tapestry I, William Brunson

New England Digital - NED
- Formed by Alonso and Jones (1975)
- Controlled with a NOVA minicomputer
- Contract with Norlin (of Moog heritage, 1976)
- Dropped by Norlin (1977)
- Developed 16-bit computer called ABLE (1977)
- Appleton returns from Sweden and resumes working on this project (1977)
  - Kapingamarangi (1979), Sashasonjon (1981), and Brush Canyon (1986)
- *Synclavier* is born (1977)
- Joel Chadabe purchase first *Synclavier* but without the keyboard/control panel; writes his own programs in XPL
- Michel Redolfi (Groupe de Musique Expérimentale de Marseille - GMEM)
  - Purchases first system with keyboard/control panel (1977)
  - Pacific Tubular Waves (1979)

Bell Labs
- *Alles Synthesizer* designed and built (1977)
- Laurie Spiegel
  - Concerto for Self-Accompanying Digital Synthesizer (1977), composed for fiftieth-anniversary celebration of talking pictures

GRM
- *SYTER* - SYstème TEmps Reel/Realtime System, a hybrid digital synthesizer/PDP-11/60 system (1982)
- *SYTER* ported to Macintosh system creating the first version of *GRM Tools* (commercially available, 1993)

Gruppo Electronacustica di Napoli
- Founded by Giuseppe Di Guigno (1973)
- *4A* synthesizer built (1976)

IRCAM
- Di Guigno goes to Paris (1976), brings *4A*
  - Antony (David Wessel, 1977)
- *4B* finished (Di Guigno and Alles, 1977)
- *4C* completed (1979)
  - Light (Machover, 1979) and Soft Morning, City! (Machover, 1980)
- *4X* in semifinal state (1981), first digital signal processor
  - Répons (Boulez, 1981), early performance of work
  - Also used by Berio, Henry, Bayle, Barrière, Rowe, Battier, and Lippe
- *MAX* first written to control the 4X by a PDP-11 (1987)
- *MAX* ported to Macintosh connected to *4X* via MIDI with *Patcher* graphics interface (1988)
  - Pluton (Philippe Manoury, 1988) and Partition du Ciel et de l'Enfer (Manoury, 1989)

Fairlight CMI (Computer Music Instrument), first of the samplers (Ryrie and Vogel, 1980)

Synclavier II (New England Digital)
- First based on FM synthesis technology
- Sampling unit added due to market interest (sample-to-RAM and sample-to-disc)

General Development System - GDS (Crumar/Digital Keyboards)
- Based on the Alles Synthesizer acquired from Bell Labs
- *Synergy* (1983), cost effective version of the GDS

E-mu 25 (E-mu Systems, 1971)
- E-mu Systems formed by Dave Rossum and Scott Wedge (1972)
- Originally built modular synthesizers
- Licensed technology for digital scanning keyboards and integrated circuits
- *Audity* (1979), analog synthesizer ($70K)
- *Emulator I* (1981), sampler ($10K)
- *Drumulator* (1983), "affordable" drum machine
- *Emulator II* (1984), adding features such as a hard drive and higher quality
- *Proteus* (1989), 256 ready to use sounds with simple user interface; big hit!

LM-1 (Linn and Moffit Electronics, 1980)
- Funded by deposits for orders to be filled in three months
- *Linn Drum* (1982), beat Oberheim DM-X to market; sold 5,000
- *Linn 9000* (1984), drum machine/economic disaster
- *Linn Drum* MIDI Studio (1986), never released and eventually produced by Akai as the MPC-60

OB-X (Oberheim, 1979)
- Programmable, microprocessor-controlled synthesizer, expanded to eight voices
- *OB-XA* (1980), improved model of the *OB-X*
- *DS-X* (1981), digital sequencer
- *DM-X* (1981), drum machine
- *Xpander* (1983), midi analog synthesizer
- *Matrix-12* (1985), two Xpander with pressure-sensitive keyboard
- *Matrix-6* (1985), design began
- Ownership of company transferred to Oberheim/EEC owned by his lawyer; continued to work for company for 2 years
- Name sold to Gibson Guitars (Oberheim files suit for malpractice against his former lawyer)

Syrinx (Synton)
- "duophonic thing" with state variable filters, ADSRs, a ring modulator, noise, random voltage source, everything; never produced
- *Synton Hybrid Modular Systems* interfaced with PDP 11/03
- *Syntovox 221* (1980s), vocoder
- Synton also became a distributor for E-mu, Fairlight, and Linn

Syco (Peter Gabriel, early 1980s)
- Distributor of synthesizers by private appointment
- *Sycologic* (1984), analog-to-MIDI converter
- *PSP* (Percussion Synthesizer Programmer, 1984)
- *M-16* (1984), MIDI patch bay
- *The Tablet* (1984), digital recording and editing system

Syncrom (Rochat, 1983)
- Evolved from Musical Instrument Manufacturers to distribute synthesizers

Opened Spye to allow musicians to learn the instruments at their own leisure

Roland (Ikutaro Kakehashi, 1972)
SH-1000 (1973), monophonic synthesizer; followed by the *SH-2000*
System-700 (1976), complete analog synthesizer system
GR-500 (1977), first guitar synthesizer system
MC-8 (1977), stand alone sequencer
TR-808 (1980), programmable rhythm machine
Jupiter 8 (1980), eight-voice polyphonic synthesizer
Initiated discussions with American companies about MIDI (1981)
JUNO-106 (1984)
D-50 (1987)

Dave Smith (Sequential Circuits, 1981)
Presents paper at AES convention proposing the USI (Universal Synthesizer Interface)
Prophet 600 (1982), first MIDI keyboard
Prophet-T8 (1983), MIDI keyboard with 76 wooden keys, velocity sensitivity, and polyphonic pressure; sold keyboards to New England Digital

First instruments built on MIDI standard (Roland and Sequential Circuits, 1983)
MIDI a compromise between price, performance, and politics
Serial communication chosen due to cost effectiveness

Yamaha *DX-7* (1983)
First MIDI hit below $2K
Anticipated sales: 5000 units; Sold: around 200,000

Marion Systems (Tom Oberheim, 1987)
Consulting for Roland and Akai until 1991
MSR-2 (1991), MIDI synthesizer with internal synthesis module plugins

Ensoniq
Mirage (1984), 8-bit sampler, $1295!

Opcode Systems (Oppenheim)
Music software
Start when Oppenheim built a computer system (IMSAI) for the control of a Moog modular system at the Boston School of Electronic Music
Use PLAY software (Chadabe and Meyers) to interface with custom board and Moog
Establishes that Macintosh will communicate via the serial port at the MIDI clock rate (1984)
Opcode Systems officially started at Macworld Expo (1985)
Meets Zicarelli at MacFest at Stanford
Shows sequencer (Oppenheim) and DX editor (Zicarelli) at NAMM show (1985)

Dr. T's Music Software (Emile Tobenfeld, 1984)

Steinberg Research (Steinberg, 1983)
Pro-16 (1983), sequencing software
Pro-24 (1986), sequencing software for Atari 520ST
Cubase (1989), sequencing software for Atari and Macintosh; IBM version released (1992)

Digidesign (Gotcher and Brooks, 1983)
Started designing sounds for Linn, Oberheim, Simmons, and E-mu
Sound Designer (1985), digital sound editing software for Macintosh
Sound Tools (1988), digital sound interface for Macintosh
Audiomedia, Pro Tools, Session 8, etc.

IRCAM
David Wessel instigates donation of MIDI studio from Yamaha

Wessel put in charge of new personal systems department (1986)
MacMix (Freed); *MIDI LISP* (Wessel and Boynton); *PreFORME* (Boynton)
Patchwork (1988), integrated composition system with graphic interface

MidiShare (Orlarey, 1987), software enabling multiple music applications to work simultaneously; eclipsed by Apple's inferior *MIDI Manager*

Intelligent Music
M
Jam Factory

MAX, graphic object oriented music programming environment
Developed at IRCAM
Zicarelli signs agreement to work on MAX to be distributed by Intelligent Music (1989)
Opcode Systems takes over agreement to publish MAX (1990)
U2 uses MAX to trigger sequences and send time-code to video

Chapter 8, Inputs and Controls

It's long term research (Robert Moog)

CEMAMu - Centre d'Etudes de Mathématiques et Automatiques Musicales (Xenakis, 1972)
- UPIC - Unité Polyagogique Informatique de CEMAMu, computer-based system for the graphic control of musical parameters
  - La Légende d'Eer (1977), Mycenae-Alpha (1978)
- Les Ateliers UPIC - UPIC Workshops (Massy, 1985), CEMAMu production and pedagogy satellite
  - Eye on Genesis I (Yuasa, 1991)

Phonogramme (Lesbros, 1993), system utilizing imported pictures to produce image and sound
- Toca (Battier, 1993), utilized *phonogramme* in the realization

Electronic musical instruments can take on any and all shapes and sizes and can use any performance interface to control any musical parameter in real-time or non-real-time
Traditional instruments are so due to historic practice

Morton Subotnick
- Two Butterflies (1974) and Before the Butterfly (1975), utilizes muted violins to control electronic devices
- After the Butterfly (1979), utilizes a "ghost" instrument, a recording of an instrument not present, to control electronic devices
- Ascent into Air (1981), utilizes two audible cellos to control the IRCAM 4C (Di Giugno) synthesizer
- Hungers (1986) and Jacob's Room (1993), utilizes *Interactor* (Coniglio) software, a further development of Vercoe's *score following* paradigm, to track performers' actions to control devices

Events in the Elsewhere (La Barbara, 1990), utilizes *Interactor* to track her voice to control video

Tod Machover
- Valis (1986-87), utilizes only two instrumentalist and the 4X processed voices (Di Giugno) to foreshadow the concept of the *hyperinstrument*
- *Hyperinstrument*, the extension of a performer's actions to expand the musical result
- Begin Again Again (1991), utilizes the *hypercello* to effect the work on an increasingly larger structural and timbral scale as the work progresses

Multiple-Touch-Sensitive Keyboard (Moog, 1972), under a commission from John Eaton, localized control in the fingertips; started in 1977 at Big Briar and finally delivered to Eaton in 1991!
- Genesis (Eaton, 1992), composed for the MTS Keyboard but found MIDI modules were unable to handle the degree of sensitivity afforded by the keyboard

Big Briar (Moog, 1977), company specializing in alternative controllers (touchplates, theremins, ribbon controllers, ultrasonic sensors, etc.)

Electron Farm (Kramer, 1972), design and construction of synthesizers (orig. from CBS Buchla 100 parts inventory)
- PASS - Public Access Synthesizer Studio (1977)
- Harvestworks, supported PASS and Electronic Art Ensemble
- Clarity (1981), licensed technologies to Lexicon, et al

Zeta MIDI violin

Synthophone (Hurni, 1981), prototype of a controller utilizing sensors and microprocessors to transform a traditional saxophone; first commercial model available in 1986 (Softwind Instruments)

IR-violin (Beyls, 1990), altered violin with infrared transmitter and receiver as sensors

trombone-propelled-electronics (Collins, 1986)

Real Electronic Music (1986), Tobabo Fonio (1986), and 100 of the World's Most Beautiful Melodies (1989)

Guitar controller (De Marinis, 1978), evolved into a guitar-like controller rather than starting as a modified guitar

MIDI Horn (Nelson and Talbert, 1983), controller for the brass player
Fractal Mountains (Nelson, 1988)

Celletto (Chafe, 1987), bodiless cello utilizing a pitch-to-MIDI converter

Thunder (Buchla, 1990), a hand-shaped surface with touch sensitive surface
Lightning (Buchla, 1991), utilizes wand or ring shaped transmitters to transmit information to the receiver
En Plein Vol (1991) and Trajectories (1992)

Hands (den Biggelaar, 1984; later enhanced by Rijnsburger), alternative controller for hand control; finger movement and relative position of each hand

Michel Waisvisz
Beat Concert (1984), Touch Monkeys (1987), Archaic Symphony (1989), The Scream Lines (1990), Songs from the Hands (1991), and Faustos Schrei (1994)

Power Glove (Mattel Toys, mid-1980s), unsuccessful product for the toy company but interested many musicians as a controller

Lady's Glove (Sonami, 1992), glove with flex sensors, micro-switches, and ultrasound emitter used to compose/perform What Happened II

Radio Baton (Boie/Mathews, 1987), two batons with low-frequency radio-signal transmitters over a set of receivers; grew out of performance controllers originally built for the GROOVE system
Richard Boulanger
Shadows (1987), I Know of No Geometry (1990), Concerto for Virtual Orchestra (1991), Solemn Song for Evening (1992), Virtual Encounters (1992), Three Symphonic States (1993, with Power Glove), The Dark Wind (1994), and OutCries (1995)
David Jaffe
Wildlife (1992), Terra Non Firma (1992), and The Seven Wonder of the Ancient World (1995)

Music Kit (Jaffe and Smith, 1986), software tools allowing for the power of software synthesis and the real-time interactivity of MIDI

Gordon Mumma
Ambives (1971), Telepos (1972) and TV Rerun (1992), used accelerometers as controllers

MidiDancer (Coniglio, 1989), dance movement sensors transmitted to a computer via wireless link

Macedonian Air Drumming (Rolnick, 1990) and The Persistence of the Clave (1992) used *air drums* (Palm Tree Instruments) as controllers

Theremin (Theremin, 1920), alternative controller

The Pigmy Gamelan (DeMarinis, 1973), instead of building a synthesizer built a piece

Holosound (Raes, 1972), used ultrasound technology to sense a performers movements in three-dimensional space

Very Nervous System (Rokeby, 1989), analyzed video images of a performer's movement and translated them into musical controls

Bruno Spoerri

In and Out (1991), Shake, Shuttle, and Blow (1991), Spiegelei (1992), and Did You Do? (1993)

3DIS - 3 Dimensional Interactive Space (Veitch, early 1980s), video-based control system utilizing one to twelve cameras
Hear the Dance, See the Music! (Burt and Bandt, 1989), Jazzmaze (Burt, 1991), and Sine Waves, Harbour Waves (Brassil, 1993)

Contact (Otto, 1988), desktop control surface containing ninety-one knobs, switches, and faders

Crackle Box (Waisvisz, 1976), a touch sensitive hand size wooden box containing electronics and a speaker that "crackled" when touched.

Chapter 9, Making Sound

I don't think that most people are aware of how commercial software colors their musical process and causes standardization (Barry Truax)

Joel Ryan, "The rules of thumb of engineering are basically antithetical to the development of musical instruments."

Stan Tempelaars (Institute for Sonology), musical sounds are modulated: global modulation, pitch and general loudness; micro-modulation, change from instant to instant (internal, generated by the properties of the instrument and external, from performer's input)

ACROE - Association pour la Création et la Recherche sur les Outils d'Expression (Cadoz, Luciani, and Florens, 1978)
Cordis-Anima for the modeling of physical systems; "to research the equilibrium between what, in a sound event, precedes from the gesture and what proceeds from the instrument"

The voice has been viewed by many as the model for an ideal synthesizer: IRCAM's CHANT (Rodet) and CCRMA's Spasm (Cook) are examples that could be based on this concept
Anticredos (Wishart, 1980), uses the voice to produce primarily non-verbal sounds

Joan La Barbara
New Wilderness Preservation Band, helped her extend her timbral awareness and vocabulary
Hear What I Feel, performance piece
Began to explore the "beautiful in strangeness"
Vocal Extensions (1975), electronics to extend the voice
Autumn Signal (1978), uses Buchla equipment to process and spacialize her voice
73 Poems (1993), uses electronics to differentiate the author's double texts, one light and one dark

Santur Opera (Ivan Tcherepnin, 1976), uses filters and modulators by Serge Tcherepnin to expand the range of sounds traditionally performed on the santur (Iranian lute)

Simon Emmerson
Established studio at City University of London in 1976
Ophelia's Dream II (1979), Time Past IV (1984), and Sentences (1990)
Second performer, additional performer to manipulate electronic from the audience's perspective

Alcides Lanza
Ekphonesis II (1968), uses a Putney synthesizer to modify the human voice in real-time
Trilogy, combines Ekphonesis V (1979), Penetrations VII (1972), Ekphonesis VI (1988) as a full-evening solo opera accompanied only by the tape and digital signal processing
Electronic extensions, using digital signal processing to grade the comprehensibility between clear semantic meaning and abstract sound

EIS - Expanded Instrument System (Oliveros, mid-1960s), to extend, enhance and transform her improvisations on accordion by controlling digital signal processors via foot pedals and switches.
Further developed with Panaiotis (late 1980s) and David Gamper (1990s)
Deep Listening Band (Oliveros, Gamper and Dempster), play the EIS collectively

Perfect Lives (Ashley, 1977-1983), video opera which required "Buddy," the worlds greatest piano player to play on a piano which is transformed over 3.5 hours; accomplished with an acoustic piano transformed into an electric piano with microphones

Edge, U2's lead guitarist, accomplished his signature sound through the unique combination of old and new technology

String Quartet No. 1: In Memoriam… (Motague, 1993), uses amplification and electronic sound to develop sounds that go beyond the traditional, *super instruments*

Kaija Saariaho
- Vers le Blank (1982) and Jardin Secret I (1984), uses IRCAM's CHANT to generate sounds
- Stilleben (1988), composed by transforming "environmental and singing and orchestral sounds." Focuses on extending instrumental sounds
- Nymphea (1987), uses string quartet and their independently and differently processed to form them into the work's harmonic structure
- Amers (1992), for cello, synthesizer, sampler, and various amplified acoustic instruments uses each string of the solo cello processed individually
- Io (1987), uses an analysis of a double bass sound as the starting point

Shozyg (Davies, 1968), instrument containing small amplified objects
- Concert Aeolian Harp (1972), used amplified jigsaw blades which were struck, bowed, plucked and blown; by 1986 it included springs, a plastic wheel, and a section of "rainbow" computer cable.

Wave Drum (Mori/Korg, 1995), an acoustic drum transformed by internal digital signal processing system

frequency modulation, an audio rate carrier oscillator's frequency is transformed by an audio rate modulating oscillator creating spectrum enhancing sidebands whose number and intensity are related to the ratio between the modulator amplitude and it's frequency; the c:m ratio determine the placement of the sidebands

Julius Orion Smith, CCRMA, to deign an electronic instrument as a model of a familiar instrument to extend the possibilities of the instrument beyond physical limitations (physical modeling, waveguide synthesis, or virtual acoustics)
- Silicon Valley Breakdown (Jaffe, 1982), uses the Extended Karplus-Strong Algorithm he developed with Julius Smith
- Perry Cook
  - *Whirlwind*, a physical meta-model combines trombone, flue and clarinet models
  - HIRN, meta-wind instrument controller which sensed bite, breath pressure, keys, linear slide, and rotation controls

CNMAT - Center for New Music and Audio Technology (UC Berkeley)
- David Wessel
  - Along with Jean-Claude Risset, disagrees with the physical model approach
  - Sees additive synthesis as the solution to electronic sound as it speaks directly to the ear
  - With Rodet, Freed, and Goldstein develops a "fly-by-wire" system to control additive synthesis using a neural network as an adaptive system

SSP - Sound Synthesis Program (Koenig, 1970), describing the wave form in terms of amplitude and time values in order to get away from the classical instrument paradigm

Sawdust (Brun, 1972), a series of explorations that allow the user to control the smallest part of waveforms (grain, quanta or wavelet)
- Dust (1976) , More Dust (1977), More Dust with Percussion (1977), Dustiny (1978), A Mere Ripple (1979), U-Turn-To (1980), and I toLD YOU so! (1981)

Musiques Formelles (Xenakis, 1963), early proposal for *granular synthesis*

Barry Truax
- Develops granular techniques into a sound generating algorithm
- Joins faculty of Simon Fraser University
- Sonic Landscape No. 3 (1977), Androgyny (1978), and Arras (1980)
- Leads to the idea through granulation that sound and structure were no longer separate
- University acquires DMX-1000 digital signal processing system
- Ports POD software into PODX for real-time control of the DMX-1000
- Wave Edge (1983), Solar Eclipse (1985), and Riverrun (1986) composed with this system
- The Wings of Nike (1987) and Pacific (1990) granulate recorded sounds

Dave Smith, The general user doesn't want distinctive sounds

Edgard Varèse, "I need an entirely new medium of expression: a sound-producing machine (not a sound reproducing one" (1939)

Jean-Claude Risset, "The easier a system is to use, the more limited are its possibilities"

Paul Lansky, "The most interesting music is generally going to be by people who have taken the design of their instruments into their own hands"

Larry Austin, "The only constraints that affect my work are those that I define—I have several very powerful software synthesis packages, including Csound and Cmix…"

Csound (Vercoe, 1985), a translation of Music-*n* programs (a la Mathews) is now possible to run in real-time on a microcomputer

Cmix (Lansky, 1986), a toolkit which makes instrument design easy

MacMix (Freed, 1985), Macintosh graphical interface connected to a VAX 11/780 for sound editing
Freed commissioned IMS to build a specialized hardware device to replace the VAX and called *Dyaxsis*
IMS is purchased by Studer and renamed Studer Editech
Clang-tint (Roads, 1995), used the *Dyaxsis* system

CSC - Centro di Sonologia Computasionale (University of Padua)
Dashow, De Poli, Vidolin, and Rampazzi
Dashow and Tisanto implement Music IV-BF (1974)
Acquire 4I synthesizer from IRCAM (1984)
LIBM - Laboratorio permanente per l'Informatica Musicale della Biennale di Venezia, organized as an event organizer by Vidolin out of CSC
Dashow designs a personal DSP system, Music 30, from the 320-C30 Texas Instrument DSP chip
Reconstructions (1992) and Morfologie (1993)

ISPW - IRCAM Signal Processing Workstation (1988), specialized
DSP environment housed in a NeXT host as a successor to the 4X
NoaNoa (Saariaho, 1991), Près (Saariaho, 1992), En Echo (Manoury, 1994), …explosante-fixe (Boulez, 1994), and Music for Clarinet and ISPW (Lippe, 1992)
Cort Lippe, "It was everything I was looking for…"
ISPW was finished as NeXT stops making computers

IRIS - Istituto di Ricerca per l'Industria dello Spettacolo (Paolo Buontempi, 1987), began to try and simplify the 4X as the MARS (Musical Audio Research Station)
Sylviane Sapir becomes manager of MARS software development
Stockhausen, Kessler, Sciarrino, Richard, and Berio use MARS

CERL - Computer-based Education Research Laboratory (University of Illinois)
Carla Scaletti and Kurt Hebel meet in 1981
Platypus (Hebel and Haken, 1984), a RAM-based micro-programmable digital signal processor
Kyma (Scaletti, 1985), Mac Plus-based software synthesis system
Funding for music hardware dries up

Bruno Spoerri, "MIDI? At the moment, it's the only way to live."

Chapter 10, Automata

It wasn't that obvious that you could be interested in music and science and technology and not be a candidate for a psychiatrist's couch (Barry Truax)

Water wheel powered bellows for a pipe organ (1644)
Panharmonicon, (Maelzel, early 19th-cent.) orchestra of 42 robot musicians; Beethoven composed Wellington's Victory for this instrument
Musical Dice Game (Mozart), use of randomness in musical composition

John Cage
- "It is thus possible to make a musical composition the continuity of which is free of individual taste and memory (psychology) and also of the literature and 'traditions' of the art" (1952)
- Birdcage (1972), composed at SUNY Albany, Joel Chadabe assisting.
- Cage would not and did not use randomness in a completely unconstrained free-for-all where anything was possible anytime in any composition. Cage differentiated and defined his compositions by the questions he asked.
- Reunion (1968), a five-hour series of chess games played by Cage against Marcel and Teeny Duchamp on an electronically wired chessboard (Cross) that "gated" through loud speakers the music produced by Cross, Tudor, Behrman, or Mumma

Accidents (Austin, 1967), piano work for Tudor in which the performer only plays the piano on accident

Tamas Ungvary, working at EMS in Stockholm, composes focusing on the instability of the EMS hybrid system

Earth's Magnetic Field (Dodge, 1970), work whose pitches and rhythms were taken from "Bulletin No. 18" of the International Association for Geomagnetism and Aeronomy

Lajaren Hiller and Leonard Isaacson
- Began working on a series of experiments in automatic composition in 1955
- Illiac Suite for String Quartet (1957)
- composition by rule; generate-and-test principle

Norbert Wiener, "Messages are themselves a form of pattern and organization…the more probable the message, the less information it gives. Clichés, for example, are less illuminating than great poems."

HPSCHD (1969), collaboration between Hiller and Cage on a commission from harpsichordist Antoinette Visher.
- Cage develops computer subroutine to generate random numbers called ICHING
- Cage wrote three programs, the first of which is DICEGAME to produce seven version of a harpsichord score; second program, HPSCHD, incorporated subroutines previously written (for Computer Cantata and Algorithms I) to compose 51 audio tapes, each of 20 minutes in duration that utilize equal-tempered scales of five to fifty-six divisions to the octave
- First performance at the University of Illinois

Herbert Brun
- Anepigraphe (1958), WDR in Cologne
- Klänge unterwegs (1962), at Siemens Studio in Munich
- Invited to become a NSF research associate at the University of Illinois by Hiller in 1963
- Futility 1964, for tape
- Works with software package, MUSICOMP, on the IBM 7094
- Sonoriferous Loops (1964) and Non Sequitur VI (1966), both composed with *MUSICOMP*
- Begins working on the Illiac II using FORTRAN in 1967-68
- Infraudibles (1968), music, and Mutatis Mutandis (1968), graphics

Iannis Xenakis

Coins the term stochastic music in 1956 to describe music based on the laws of probabilities and the laws of large numbers
Achorripsis (1957), for orchestra, uses Poisson distribution to determine timbre, pitch, loudness, and duration
Makes contacts within IBM-France to give him a place and tools to continue his work
ST/48-1,240162 (1962), Amorsima-Morsima (1962) and Atrées (1962), performed at IBM-France on 24 May 1962 (all for acoustic ensembles)

Gottfried Michael Koenig
Studies computer programming while at WDR in 1960
Begins to write out of serialist ideas the program *PR1* (Project 1); moves to Utrecht in 1964 and finishes *PR1* in 1967
Beitrag (1986), for orchestra, written using *PR1*
Begins work on PR2 in 1968, which becomes "a complicated program" so he mostly uses *PR1*
Extends *PR1* to interface with the *VOSIM* oscillators in 1978 resulting in *PR1X* and then modifies said in 1979 in *PR1XM*
Output (1979), uses *PR1XM*

Otto Laske
Invited to work in Utrecht by Koenig in 1970
Works with *PR1* and the analog studio
Interest in generative musical grammars as an extension of Pierre Schaeffer's "objet sonores" and his defined need for a treatise on how these objects are linked
Develops the theory of musical "competence", "performance", and (task) "environment" through the 1980s and later includes "biography"
"With hindsight, I realize that my main interest was always in creativity…"

Barry Truax
After complete graduate school in 1971 he goes to Utrecht for further study
Laske's work becomes influential as a study of musical behavior, as against musical artifacts
Begins to develop the *POD* (POisson Distribution) programs
Chowning visits Utrecht in 1973 and plays Turenas
Chowning visit leads Truax to introduce dynamically changing sounds to the *POD* system
She, a Solo (1973), for mezzo-soprano and tape composed in the analog studio
Gilgamesh (1974), for large ensemble and twelve tapes; one of the tapes is prepared with the *POD* system

Algorithmic composition, a.k.a. computer-automated composition

Le Caine designs the Serial Structure Sound Generator as a "analog algorithm" system

Larry Austin
"Through the late 1960s, I was fascinated by the process. The process itself was more important than the compositional content."
Purchases a Buchla synthesizer in 1969 to compose works incorporating analog synthesizer processes
Quartet Three (1971), and Primal Hybrid (1972), performed on tape and edited
Walter 91971), Prelude and Postlude to Plastic Surgery (1971), and First Fantasy on Ives' Universe Symphony—The Earth (1975), performance pieces
"My model was improvisation. I had gotten the machine to improvise"

Chapter 11, Interaction

Everything is possible, but some things may not be easy (Larry Polansky)

Joel Chadabe
- CEMS - Coordinated Electronic Music Studio
  - Ordered from Moog in 1967
  - Installed at the SUNY Albany in 1969
  - World's largest collection of Moog sequencers under one roof
  - Contained an array of sound-generating and processing modules, an automated matrix mixer, and a digital clock
  - Drift (1970), automated composition for real-time performance
  - Ideas of Movement at Bolton Landing (1971), using joysticks to control CEMS
  - Echoes (1972), utilized the CEMS to transform in performance the sounds of the percussion, violin, cello, and trombone (from a tape delay)
- *Daisy* (Roy, 1972), a compact pseudo-random signal generator
- Studio acquires a small PDP-11 computer
- *PLAY* (Meyers and Chadabe, 1977), written as a basic software sequencer to control the analog synthesizer
  - Settings for Sprituals (1977)
- *design-then-do*, use for all works of this time

- Purchases Synclavier system from NED in 1977
  - Roger Meyers designed a software structure for the flexible and interactive scheduling of musical events
  - Solo (1978), uses Meyers' structure in which to write a program performed with two proximity-sensitive antennas (a la theremin)
  - Playthings (1978), piece were the audience was invited to interact with the antennas
  - Scenes from Stevens (1979) and Several Views of an Elusive Lady (1985)
  - Bar Music (1985), using some keys on a keyboard as control keys
  - Rhythms (1980) and Follow Me Softly (1984), with percussionist Jan Williams
- coins the term *interactive composing*

Salvatore Martirano
- "My father as a builder of public building, so building was part of my growing up—building instruments was a normal idea for me"
- Underworld (1965), uses a spacialization system designed by the composer
- Works toward the development of a piano that would have a dedicated magnetic pickup in 1964-65
- Cocktail Music (1962), uses a system of underlying patterns and permutation as an evolution of serialism
- Reads Digital Electronics for Scientists (Malmstadt and Enke) in 1966
- *Malmstadt Enke Blues* (1967), an instrument based on algorithms and pattern manipulation
- *Marvil Construction* (Martirano and Divilbiss, 1968), real-time performance instrument
- *SalMar Construction* (Martirano and Divilbiss, 1969), added touch sensitive switches
  - Engineers Franso, Borovec, and Barr (and later composers Sekon and Mohn) join the project
  - Finished in 1972

GAIV - Groupe Arts et Informatique de Vincennes
- Founded in 1969 by Greussay (composer) and Huitric (painter) at the University of Paris VIII in Vincennes
- Exemple (1970) and Expérience pour Como (1970), using several VCS-3s purchased in collaboration with students
- Given an Intel 8008 (an early small computer)
  - Connected to analog synthesizers, four or five VCS-3s, through DACs controlled with the 8008 programmed through the *Intelgreu* (Intel + *Greu[*ssay]) assembly language
- Sept heures d'activités continues autour de mini-ordinateurs… (1978), a group performance by Greussay, Englert, Arveiler, Battier, Dalmasso, and Roncin
  - Girolles et Autres Campignons (Englert, 1978), based on ideas developed in four programs (*Melanzane*, *Fragola*, *Basil 2*, and *Girolle*)
- Englert purchases a Synclavier in 1978
  - Roncin built a sixteen channel control device incorporating two joysticks and twelve sliders

Juralpyroc (1981), software controls sound contours, durations, timbre, and pitches through probability that is interactively weighted during performance by Englert
Quantuor 'S' (1979), Les Dits d'Amenhotep XIX (1980, Suite Ocre (184), and Model 'S' (1984)

Mills College
League of Automatic Music Composers and later *The Hub*, developed interactive composition via computers
The League was started by graduate students Horton, Bischoff, and Gold
Horton first performs with the *KIM-1* computer, purchased for $250, in 1971
The League concertized extensively in the Bay Area during 1979 through 1983
Perkis and Bishoff builds a connecting box and called it "the hub" in 1984
The Hub was formed by Perkis, Bishoff, Gresham-Lancaster, Stone, Brown, and Trayle
Each member composes works for the group
Is It Borrowing or Stealing (Stone, 1987) and The Minister of Pitch (Perkis, 1988)
Gresham-Lancaster designed a MIDI interface to coordinate the group's communication; this allows each composer to use their own computer and sound generating equipment

David Behrman
Voice with Melody-Driven Electronics (1975), for an array of pitch sensor that controlled special circuits and Joan La Barbara, commissioned by the Merce Cunningham Dance Company
Cello with Melody-Driven Electronics and Trumpet with Melody-Driven Electronics, part of a series of "very simple, minimal music"
The Cunningham Dance Company supported its composers by producing concerts in conjunction with a tour
On the Other Ocean (1977), interactive composition written for KIM-1 computer, six pitch sensors, homemade synthesizer, flue and bassoon

George Lewis
Trombonist and composer visits Mills College in 1976 and is exposed to improvising computers (KIM-1s)
Trio by Candlelight (1977) and Chicago Slow Dance (1977), for electronic ensembles; Atlantic (1978), for amplified trombones with resonant filters; The Imaginary Suite (1978), for tape and instruments; The KIM and I (1979), for microcomputer, synthesizer, and improvising musician; Chamber Music for Humans and Non-Humans (1980), for computers and improvising musician; Minds in Flux (1980), for tape; A Friend (1980), for dance and tape; Homage to Charles Parker (1980), for electronics with instruments; Unison (9178, revised 1982), for soloist and score-following interactive computer program; Rainbow Family (1984), for interactive composition for computer with pitch sensor, synthesizer, and acoustic melody instrument; and Voyager (1987), for soloist and "interactive computer music composer-listener"

David Rosenboom
Begins work at SUNY Stony Brook with biofeedback researcher Les Fehmi in 1968
Starts to work at York University in Toronto in 1970
Ecology of the Skin (1970), create music based on the psychological state of the user wearing EEG sensors
Formed the Laboratory of Experimental Aesthetics at York
Portable Gold and Philosophers' Stones (1972), sound controlled by brain waves, galvanic skin response, and body temperature; Chilean Drought (1972), using biofeedback; On Being Invisible (1977, revised as On Being Invisible II in 1995), were feedback was based on ERPs
Joined the faculty at Mills College in 1979
Begins to work with the Buchla *Touché* synthesizer
Develops *FOIL* - Far Out Instrument Language
Becomes the director of the Center for Contemporary Music at Mills College
HMSL - Hierarchical Music Specification Language, begun with discussions between Rosenboom, Polansky, and Tenny was up and running by 1981
Polansky, "Everything is possible, but some things may not be easy"
Phil Burke, one of the developers from the beginning, becomes full-time project software engineer due to a grant from The Inter-University Consortium on Educational Computing; transforms *HMSL* into object-oriented language for Macintosh and Amiga
Zones of Influence (Rosenboom, 1986), for percussionist and *Touché* written in early *HMSL* and *FOIL*

Larry Polansky

B'rey'sheet (1984), based on the singing of the 11th and 12th cantillation melodies from the Torah; 17 Simple Melodies (1987), a *HMSL* program with only fundamental structures defines inviting the performer to specify the details; Cocks crow, dogs bark, this all men know, but even the wisest, cannot tell, why socks crow, dogs bark, when they do (1988); Horn (1990); 3 Studies (1990); There is more headroom, but one's feet are force into slipper of steel (1991); The World's Longest Melody (1993); The Birth of Peace (1989 with Chris Mann, Alistair Riddell, Simon Veitch, et al); and Dear John (1986, with Pauline Oliveros)

Peter Beyles

Tea for Two (1975), for two electronics performers; Heartbeat (1976), using a performers ECG signals; Crosstalk (1980, for live electronics; and The Hollow Man (1980), Painted Words (1981), Heading into the Storm (1985), all performances with computer

Focuses on interactive and intelligent systems at Brussels University artificial intelligence laboratory in the mid-1980s

Uses *HMSL* for creating *Oscar* (*Osc*illator *ar*tist), a knowledge-based performance companion, in 1985

Felix Hess

Electronic Sound Creatures (1983), 40 machines packaged in little aluminum boxes that react to the audience and each other; finished in 1983 at STEIM in Amsterdam

Moving Sound Creatures (1987), 24 small machines with two wheels, a bumper, and two microphones extended above the machine on a shaft

Roger Dannenberg

Starts to work on score-following programs in 1983

In pre-Macintosh days, "The sound was very crude but it was adequate and the whole thing fit into a little case that fit under an airline seat"

Shows system at the 1984 ICMC

Jimmy Durante Boulevard (Bloch, 1985), works with Dannenberg on piece for three performers (Bloch on keyboard, Dannenberg on trumpet, and Chabot on flute) where the computer system acted as the composer's agent to focus the live performers towards a more structured performance

Richard Teitelbaum

Returns to New York from working with *MEV* in Rome in 1966 to build a synthesizer and study biofeedback techniques

Synthesizer built from modules he built and those from Moog; performs on keyboardless system by twirling knobs and changing patch cords

After working with Steve Lacy on an improvisational setting of Lao Tzu's The Way, he returns to MEV in Rome in 1967

Organ Music (1968), using brain waves and heartbeats

In Tune, brain waves controlling a synthesizer with processed heartbeats and breath sound

Alpha Bean Lima Brain (1971), brain waves transmitted via phone lines from Cal Arts made a pot of beans jump at the Avant Garde Festival in New York

Tai Chi Alpha Tala (1974), brain waves of a Tai Chi performer controlled a raga-playing sequencer accompanied by a live Indian drummer

Aspects (Duo) (1974) and Time Zones (1976), improvisations with Anthony Braxton

Blends (1977) for shakuhachi, percussion, and synthesizer

Colorless Green Ideas Sleep Furiously (1976), title is a sentence by Noam Chomsky to demonstrate that grammar did not necessarily generate meaning

Finds the difference between electronic instruments and acoustic instruments is the subtlety of the response

Loaned a s *Pianocorder Vorsetzer* to extend the piano (actually two such player piano systems with a controller piano attached)

Developed *PCL* - Patch Control Language, as an object-oriented language used to design interactive music environments

Solo for Three Pianos (1982) and Concerto Grosso (1985), use *PCL*

Salvatore Martirano

SAL - Sound And Logic, begun in 1986, as a performance program written in Le LISP

YahaSALmaMAC Orchestra (1986), a "real-time answering service" consisting of a Macintosh II, synthesizers, and a drum machine
Purchases a *Kyma* system in 1992
SAL is translated into *SAL80* by Walker for use with the *Kyma* system
SAL80 is used as the basis for *ImprovisationBuilder* containing "listeners", "players", and "realizers"

Robert Rowe
Cypher, a listening program started in 1987
Flood Gate (1989), Sun and Ice (1990), Banff Sketches (1991), Maritime (1992), and Shells (1993)
Additional specific "listeners" developed for Not About Water (1994) and A Flock of Words (1995)

Intelligent Music
Started with no capital and great vision in 1993
M, 1986 Macintosh port by David Zicarelli of the work Chadabe had been doing on the Synclavier
Jam Factory, Zicarelli's improvisation software
OvalTune, another program by Zicarelli that extends his interactive concepts

Carl Stone
Sukothai (1979), composed at KPFK using a turntable and two stereo tape recorders (names after a restaurants in the Los Angeles are)
Kuk Il Kwan (1980), using a stereo *Publison* digital-delay harmonizer with recordings (commercial, soundscapes, urban, etc.)
Dong Il Jang (1982), for microphone, phonograph, recordings, and *Publison*
Hop Ken (1987), Wall Me Do (1987), Amatersau (1988), Jan Toh (1988), Nekai (1988), and Gadberry's (1989), utilizing *M* as his instrument (along with a TX-816 and Prophet 2000 bought with the insurance check from the theft of his studio)

Giuseppe Englert
Working with GAIV in 1986
Mus Est Syllaba (1987), Basilico (1988), Dodeca (1989), and Plusieurs Multiples (1990), using *M*
Metro 3 (Lesbros) software was designed to allow for up to eight independent voices with each voice having control over timbre, tempo, rhythm, loudness, melody patterns, and random processes
Sopra la Girolmeta (1991), composed using *Metro 3*

Francisco Kröpfl
AREM - Algoritmos para la Reinterpretacion de Estructuras Musicales (Calzon, 1990), program for the probabilistic transformation of performance input to output; programmed in MAX
Incursions in the Arem (1993), using AREM to respond to the performer with it won personality

Bruno Spoerri
Became one of the founders of the *SSCM* - Swiss Society of Computer Music in 1982
SSCM holds first concert in 1983 with guests Max Mathews and Jean-Claude Risset
SCCM - Swiss Center for Computer Music, founded in 194 by Spoerri, Greco Boesch, and Bennett
Controlled Risk (1986), using a MIDI feedback situation from two pitch-to-MIDI converters
Drum Song (1986), using *Jam Factory*
Rue du Cerche-MIDI (1987), using *M*
A Digit for Dr. Diamond (1989), using a prerelease version of *MAX*

Chapter 12, Were Are We Going?

And as we learn how to make it, we'll learn how to play it—
and the other way around (Joel Chadabe)

Bruce Pennycook
- "The players that we see on a day to day basis out there making music are the players of traditional instruments—I'd like to have my pieces played live in the kind of venues that attract music lovers as those venues have for hundreds of years"
- Praescio-I (1986), for saxophone player triggering sound events via a MIDI footpedal
- Praescio-II Amnesia (1988), for soprano, flute, violin, cello, and keyboard synthesizer, the keyboard player triggering sequences of notes and effects
- Praescio-III The Desert Speaks (1988), for harpsichord and electronics, the different registers of the harpsichord trigger accompaniment events in a pre-composed list
- Praescio-V Frontline (1990), for trumpet, saxophone, and computer-MIDI-system uses MIDI-LIVE software that is controlled by switches installed on both instruments
- Praescio-IV (1990, after Praescio-V), uses special keys on a clarinet to trigger electronic events

Michel Redolfi
- Underwater pieces where audiences floated and dived while listening to these concerts
  - Sonic Waters (1981), performed with a Synclavier over hydrophones (first in the ocean and later in public pools)
  - Sonic Waters II (1983-89), performed with a Synclavier II; L'écume de la Nuit (1984), for the Roman baths in Strasbourg, and Crysallis (1992), an opera composed for the Olympic pool in Grenoble

Electroacoustic music lends itself to a wide variety of venues including extravagant environments, interactive installations, CD-ROM, and the WWW

Extravagant Environments
- Phillips Pavilion (Brussels World's Fair, 1958), designed by Iannis Xenakis
- Pepsi Pavilion (Japan Expo '70), including artificial fog, gigantic spherical mirror, robots, special lighting system

Spectacles
- Christian Clozier (mid-1980s), at locations such as Piazza San Marco in Venice, the Château de Cambord in the Loire Valley, the Château de Versailles, and the Bourges Cathedral
- Iannis Xenakis' *polytopes,* Polytope de Montréal (1967), polytop at Persepolis in Iran (1971), Polytope de Cluny (1972), Polytope of Mycenae (1978), Diatope (1978) with La Légende d'Eer (1977)
- Woody and Steina Vasulka, combining video and music began their explorations as early as 1970

Interactive Installations
- Well (Tony Martin, 1969), used vibrating mercury and transducers to sense people's hand movements
- Sunspots (Liz Phillips, 1981), used theremin-type to detect movement in a gallery space
- Talkshow (Lansky, 1988), used speech to activate rhythmic and speech templates, with the sounds made by synthesizers
- Ich auch Berlin(er) (Paul DeMarinis, 1993), used a dichromate hologram of a 78 rpm record of the "Beer Barrel Polka" played on a transparent turntable by a green laser
- Ron Kuivila
  - Il Giardino di Babele (1990), used a trompe l'oeil blue moon on the top floor of the tower in the piazza Poggi; a garden in which the alarms and chimes of 500 watches started sounding at nightfall and continues in staggered fashion throughout the next hour; and a playing field in which people's movements affected sounds
  - Der Schnueffelstaat (1991), video images changed from crosshairs to Swiss flags when motion was detected in the room
  - Singing Shadows (1994), video sensing system scanned shadows whose shape controlled the musical processes

In Thin Air (Behrman, 1995), used footpedals, buttons, and light-beam sensors around a gallery space with which the public could interact

Barton and Priscilla McLean: The McLean Mix

Two threads developed through their work: nature and interactivity

Beneath the Horizon I (Priscilla McLean, 1978), used a tape of whale sounds; and In Wilderness Is the Preservation of the World (1985), included projections and environmental and animal sounds

Rainforest Images (1993), used recorded sounds of the Peruvian Amazon, Australia, and other "far flung places", along with didjeridoos, voices, and instruments; all were processed in collaboration with Panaiotis using the EIS - Expanded Instrument System at the Oliveros Foundation

Rainforest, an installation were a taped drone of recorded and synthesized sounds and continuous projections of rainforest images provide an atmosphere in which members of the public are invited to perform on electronic and acoustic instruments

CD-ROMs

Max Mathews conceived of a system that would allow the user to purchase a score on transportable media and conduct an individual interpretation of the music; this resulted in the Radio Baton and Conductor Program

Intelligent Music's business plan included the development of an interactive instrument for the home entertainment market

All My Hummingbirds Have Alibis (Subotnick, 1993), the first musical composition created specifically as a multimedia CD-ROM, allows the user to select the order of sections and visuals

Xplora 1 (Peter Gabriel) allows the user to move virtual faders in order to create their own mix

No World Order (Todd Rundgren), allows the user to control the tempo, mood, mix, and musical events

Interactive Software

Laurie Spiegel

Intelligent musical instrument (with Mathews, 1973), let people play music on a compositional level

"…it becomes possible for more people to make more satisfying music, more enjoyably and easily, regardless of physical coordination or theoretical study, of keyboard skills or fluency with notation. This doesn't imply a dilution of musical quality. On the contrary, it frees us to go further and raises the base-level at which music making begins."

Was a co-developer of the Apple II-based *alphaSyntauri* music system

Nomads (1981) and A Harmonic Algorithm (1981)

Extended the *McLeyvier* system into IMP - Interactive Music Processor in 1981

Three Modal Pieces: A Cosmos, A Legend, A Myth (1983), Harmonic Rhythms (1983), and Immersion (1903)

Finishes *Music Mouse* in 1985 as an *intelligent musical instrument* for the Macintosh, Amiga and Atari computers

Cavis Muris (1986) and most of the CD Unseen Worlds (1987-90)

Sound Effects Improvisation (Warren Burt, 1993), used Music Mouse with the addition of a Buchla *Lightning*

World Wide Web

Public Organ: An Interactive, Networked Sound Installation (Scaletti, 1995), introduced simultaneously on the WWW and at the ICMC in Banff; invites participants to experience linking, lurking, looping, and collective thinking through interaction

Appendix 1, Terms and Abbreviations

ADC	Analog to Digital Converter
ADSR	Attack, Decay, Sustain, and Release (see EG)
AES	Audio Engineering Society
ASA	Acoustic Society of America
CEC	Canadian Electroacoustic Community
DAC	Digital to Analog Converter
DSP	Digital Signal Processor
EBU	European Broadcasters Union
ECG	Electrocardiogram
EEG	Electroencephalogram
EG	Envelope Generator
ERP	Event-Related Potentials
ICMA	International Computer Music Association
ICMC	International Computer Music Conference
MMA	MIDI Manufacturers Association
NAB	National Association of Broadcasters
NAMM	National Association of Music Merchants
NSF	National Science Foundation
SAN	Sonic Arts Network (United Kingdom)
SEAMUS	Society for Electro-Acoustic Music in the United States
SMPTE	Society of Motion Picture and Television Engineers
S/PDIF	Sony/Phillips Digital Interface Format
TDIF	Tascam Digital Interface Format
VCA	Voltage Controlled Amplifier
VCF	Voltage Controlled Filter
VCO	Voltage Controlled Oscillator

Appendix 2, The Fundamental Physical Quantities[1]

fundamental physical quantities - length, time, and mass
derived units - obtained by combining fundamental units (i.e. square meter, cubic meter, et al)
physical quantities - objects and concepts described by using numbers

LENGTH

length - measured distance or dimension
distance - spatial separation of two points [D=S*t]
measurement - how many times a unit is contained in the given distance
displacement - moving an object from one place to another
magnitude - amount of displacement
vector quantity - physical quantity containing both direction and magnitude (identified by *vc*)

TIME

time - a non-spatial continuum in which events occur in apparently irreversible succession
velocity - rate at which an object's displacement is changing *vc*
speed - magnitude of the velocity [S=D/t]
acceleration - rate at which velocity is changing *vc*
deceleration - rate at which velocity is changing (negative acceleration) *vc*
[a/bc=acceleration; a=amount of speed change, b=unit of time measurement, c=time required to accomplish speed change...ie. second. in the metric system the unit of acceleration is 1m/sec2]

MASS

mass - a unified body of matter weighing - process by which the mass of an object can be compared to a standard mass
force - push or pull to create distortion of acceleration in a piece of matter [F=M*a; one unit of force in the metric system is the newton. 1Kgm/sec2=newton (N)]
weight - the force of gravity acting on a mass
equilibrium - two forces acting have balanced or canceled each other
friction - opposite force to acceleration or distortion
momentum - the property of a mass in motion to remain in motion

PRESSURE

pressure- amount of force action on each unit area [p=F/A]
ambient pressure - actual value of the atmospheric pressure at a given place and time
sound - sensation produced by rapid changes in ambient pressure

WORK

work - force use to move a given distance [W=F*D]
joule - unit of work in which one newton acts through a distance of one meter

ENERGY (MECHANICAL)

potential energy - energy a system can have because of its configuration
kinetic energy - energy a system can have because of its motion

POWER

power - the rate at which work is done

LAWS

law of gravity - every piece of matter exerts an attractive force on every other piece of matter
law of conservation of energy - energy can not be created of destroyed, but can only be transformed from one form into another.

[1] excerpted from Backus, John, The Acoustical Foundations of Music, 2nd ed. (New York: W. W. Norton & Company, 1977)

Introduction to Emu/Quiz 1

MUC 4311/5315-SAIN 9.24.99

The following quiz contains material from assigned reading, listening and class lectures.

• EXAMPLE 1 •

1) This work typifies the compositions coming from the _____ during the 1950s.
   a ORTGE b. NWDR
   c. NWSA d. ORTF

2) The correct title and date of this example is:
   a. I of IV b. Fontana Mix
   c. Chef d'oeuvre d. none of the above

3) The composer of this work decided to compose an imaginary conversation, a series of (chose all correct answers):
   a. dialogues b. screaming diatribes
   c. many-voiced arguments d. monologues

• EXAMPLE 2 •

4) The composer of this work is:
   a. Jon Appleton b. Joji Yuasa
   c. Morton Subotnick d. Pierre Schaeffer

5) This piece was created with synthesizers made by Bob Moog (t/f).

6) According to the CD liner notes "electronic sequencers of the time…could repeat continuously, sounding like":
   a. a broken record b. a modern computer sequencer
   c. a tape loop d. nothing ever before

• EXAMPLE 3 •

7) The author of the work is _____ .

8) The most probable title and date of this composition is:
   a. Déserts (1949-54) b. Concrete PH (1958)
   c. Projection Esemplastic for White Noise (1964) d. Sonic Contours (1952)

9) This work was created the NHK Electronic Music Studio (t/f).

10) The only sound source used in the composition of this work is:
   a. flute b. burning embers
   c. white noise d. a burning clarinet

• EXAMPLE 4 •

11) The two Pierres that collaborated on this work have the last names of:
   a. Beaucamp & Henry b. Piper & Schallenger
   c. Henry & Schaeffer d. Schaeffer & Garrard

12) This piece was created with tape loops and speed manipulation (t/f).

13) This movement is from a larger work entitled _____ .

14) The correct movement title and year of composition is:
a. Exotica (1958) b. Eroica (1806)
c. Erotica (1952) d. Orphée (1952)

• EXAMPLE 5 •

15) The title of this work is:
a. Electronic Tonalities b. Forbidden Planet
c. Incantation d. Fatal Planet

16) The author(s) of the work is/are _____ .

17) A primary tool used in the production of this work is (best answer):
a. cybernetic circuits b. ARP synthesizers
c. Bucla synthesizers d. burning embers

• EXAMPLE 6 (not on listening list...perhaps unknown) •

18) The most probable title of this work is _____ .

19) This work uses a single recorded source for the entire composition (t/f).

20) Briefly describe the possible processes involved in producing this work (short answer):

• ADDITIONAL QUESTIONS •

21) Name one book title by Pierre Schaeffer and briefly describe its significance (short answer):

22) Many of Schaeffer's works are entitled "etudes." In one such "etude" Schaeffer uses the sounds of a train as the "concrete" element. This composition is:

a. Étude aux chemins de fer b. Études aux casseroles
c. Étude violette et noir d. Études aux tourniquets

23) The first director of the NWDR studio was Eimert (t/f).

24) In his publication, Art of and Apparatus for Generating and Distributing Music Electronically (1897), Thaddeus Cahill explained a sound generation method he would use in an instrument known as the:

a. terpsichord b. singing arc
c. telephonium d. telharmonium

25) The aetherphone (1920), a.k.a. the theremin, was licensed for production in the United States by Westinghouse (t/f).

26) What instrument arrived at the Columbia-Princeton Electronic Music Studio in 1959?

_____

27) A longitudinal wave is, for example, a plucked string instrument or water—most movement is perpendicular, up and down, to the direction of the wave (t/f).

28) Ensembles for Synthesizer (1964) was composed by _____ .

29) The music of Stockhausen was a combination of the concrète, ORTF, and electronische, NWDR, aesthetic (t/f).

30) Fontana Mix, was written by John Cage in the year:
a. 1938 b. 1948
c. 1958 d. 1968

31) According to Pierce, the problems with the dissemination and creation of early electronic music included (circle the incorrect answer below):

a) lack of audience acceptance of speaker performance
b) composers had too many tools from which to choose
c) minimal commercial recordings

• BONUS •

32) Varèse stated, "Our musical alphabet must be enriched…we also need new instruments very badly…" Does this statement still hold true today and why/why not? (short essay)

Introduction to Emu/Quiz 2

MUC 4311/5315-SAIN 10.8.99

The following quiz contains material from assigned reading, listening and class lectures.

• EXAMPLE 1 •

1) This work uses the jazz classic, My Funny Valentine, as the basis for a series of intelligent interactive computer musical processes (t/f).

2) This piece was created with a computer program called:
   a. Z b. M
   c. PDQ d. none of the above

3) The title of this composition is _____ .and was written in the year _____ by composer by _____ .

• EXAMPLE 2 •

4) The title of this composition is _____ and was written by _____ .

5) This work uses the following to achieve the instrumental parts (choose one).
   a. solo viola and Music IV b. solo bass and cmusic
   c. solo cello and Csound d. solo cello and MIDI

6) The vocal part uses extended, non-traditional and non-western, vocal techniques to obtain the various timbres (t/f).

7) This composition is based on a passage from the novel by:
   a. Virginia Woolf b. Samuel Beckett
   c. R. L. Stein d. William Shakespeare

• EXAMPLE 3 •

8) The title of this work is _____ and was written by _____ who was born in the year _____.

9) This work is for computer generated tape and _____ .
   a. barbershop quartet b. kazoo
   c. chamber singers d. baritone voice soloist

10) The composer of this work is known for his use of an analysis-synthesis approach to speech synthesis (t/f).

11) This composition is based on a poem by _____ .

• EXAMPLE 4 •

12) The title of this work is _____ .

13) John Chowning is the composer of this work (t/f).

14) What is the most probable method of sound manipulation used to produce this composition and why is it the most likely method (short answer).

• EXAMPLE 5

15) The title of this composition is:
   a. Idle Chatter b. Notjustmoreidlechatter
   c. just_more_idle_chatter d. rettcheldieeromtsujtonllitS

16) The author of the work is _____ .

17) This work belongs to a genre called (choose the most specific answer that applies):
   a. computer music b. electroacoustic music
   c. tape music d. live/electronic music

18) This work is one of a series based on the canine origin of electronic sounds (t/f).

• EXAMPLE 6 • (not on listening list...perhaps unknown)

19) A most probable author of this work is _____ .

20) Briefly describe the process involved in producing this work and why this work is electroacoustic (short answer):

• ADDITIONAL QUESTIONS •

21) The first computer music "piece" realized with Max Mathew's Music 1 was In the Silver Scale (t/f).

22) Match the following centers for computer music research and a founder/director or a researcher associated with the center (select the appropriate letter and place in the space before the center).

___ **CCRMA**	a. Barry Vercoe
___ **CARL**	b. Luciano Berio
___ **Bell Labs**	c. John Chowning
___ **IRCAM**	d. F. Richard Moore
___ **MIT Media Lab**	e. Max Mathews
___ **CRT**	f. Pierre Boulez

23) Sound can also travel through water (t/f).

24 Music IV-BF, the first software synthesis system (SWSS) to be machine independent (written in FORTRAN), was written by:
a. Vercoe
b. Howe and Winham
c. Howe
d. Truax

25) John Chowning's monumental article that lead to the creation of the Yamaha DX-7 was "On the Analysis, the Synthesis and the perception of Sounds, Studied with the Aid of Computers" (t/f).

26) Charles Dodge composed his work Any Resemblance Is Purely Coincidental (1978) for piano and a tape part based on the voice of the famous operatic tenor _____.

27) BEAST, a multi-speaker performance system, has its name based on the acronym for:
a. Big Electro-Acoustic Simulation Tonalizer
b. Basic Electronic And Sonic Thing
c. Bravarian Electro-Acoustic Sound Theater
d. none of the above

28) CDP (Composers' Desktop Project), a system for computer synthesis on the Atari ST, was the First port of SWSS to personal computer (t/f).

29) According to Bob Moog, what was the "gimmick" for 1969? (brief answer)

30) Which of the following composers worked with the GROOVE system at Bell Labs (circle all that apply):
a. Laurie Andersen
b. Emmanuel Ghent
c. Laurie Spiegel
d. Ricardo Dal Farra

31) Due to a grant from the Sloan Foundation, the Dartmouth Digital Synthesizer was used for ear training by day and lounge gigs by night (t/f).

32) Name two music technologists that lost the right to use their own last name in the music industry.

_____

_____

40) The Yamaha DX-7 was a market disappointment due to only selling 5000 keyboards (t/f).

• BONUS •

41) What are the benefits and the drawbacks of the MIDI standard? (short essay)

Introduction to Emu/Mid-Term

MUC 4311/5315-SAIN 10.15.99

The following quiz contains material from assigned reading (including liner notes), listening and class lectures.

• EXAMPLE 1 •

1) The two Pierres that collaborated on this work have the last names of:
   a. Beaucamp & Henry b. Max & Rabbit
   c. Schaeffer & Garrard d. Henry & Schaeffer

2) This piece was created with tape manipulation (t/f).

3) This excerpt is from a larger work entitled Symphonie pour un Homme Seul; the correct movement title and year of composition is:
   a. Eros (1961) b. Exotica (1958)
   c. Erotica (1952) d. Eroica (1806)

• EXAMPLE 2 •

4) The title of this work is _____ and was written by _____ in the year _____.

5) A primary technique used to produce the distinctive characteristic of this work is called (chose one):
   a. splicing b. direction change
   c. looping d. speed change

6) This technique has been used by composers of acoustic music and results in music called phase or phase shift music (t/f).

• EXAMPLE 3 •

7) The title of this work is:
   a. Collage #1 ("Blue Suede") b. Chef d'oeuvre
   c. II of IV d. Erotica

8) The composer states in the CD liner notes that this work is his Boléro (t/f).

9) The sound source used in this composition is a recording of (be specific):

• EXAMPLE 4 •

10) The title of this composition is _____ and was written by _____ .

11) This work uses the following to achieve the instrumental parts (choose one).

   a. solo viola and ISPW b. solo bass and cmusic
   c. solo cello and MIDI d. solo cello and Max

12) The vocal part uses only traditional vocal techniques to obtain the various timbres (t/f).

13) This composition is based on a passage from the novel by:
a. William Shakespeare b. Samuel Beckett
c. Theodor Geisel d. none of the above

• EXAMPLE 5 •

14) This work typifies the compositions coming from the _____ during the 1950s.
a IRCAM b. Bell Labs
c. NWDR d. ORTF

15) The correct title of this example is:
a. Déserts b. Ensembles for Synthesizer
c. Modalities d. none of the above

16) The composer of this work is _____ .

• EXAMPLE 6 •

17) The title of this composition is:
a. Chatter*chatter*chatter b. just_more_idle_chatter
c. Notjustmoreidlechatter d. Idle Chatter

18) The author of the work is _____ .

19) This work belongs to a genre called (choose the most specific answer that applies):
a. concrète music b. electronic music
c. acousmatic music d. computer music

20) This work is one of a series based on the human origin of electronic sounds (t/f).

• EXAMPLE 7 •

21) The title of this work is:
a. Transfigured Wind IV b. Transonic Wind IV
c. Transmutated Wind IV d. Transatlantic Wind IV

22) This work is for tape and tarogato (t/f).

23) What research institution built this computer music system?

• EXAMPLE 8 •

24) The title of this work is _____ and was written by _____ .

25) This work was comissioned by the:

a. Ford Foundation b. National Endowment for the Arts
c. French Ministry of Culture d. none of the above

26) The composer was also responsible for the development of a synthesis method used in the Juno 106 (t/f).

• **EXAMPLE 9** (not on listening list) •

27) The most probable composer of this work is:
   a. Åke Parmerud
   b. James Paul Sain
   c. John Adams
   d. Tom Erbe

28) This work has a similar aesthetic to one or more works on your listening list. What is this similarity and which piece(s) from your listening list have this characteristic (short essay).

• **ADDITIONAL QUESTIONS** •

29) Many of Schaeffer's works are entitled "etudes." In one such "etude" Schaeffer uses the sounds of a duck as the "concrete" element (t/f).

30) The theremin was licensed for production in the United States by RCA (t/f).

31) Match the following centers for computer music research and a founder/director or a researcher associated with the center (select the appropriate letter and place in the space before the center).

___ **CCRMA**	a. Barry Vercoe
___ **Bell Labs**	b. John Chowning
___ **CARL**	c. Pierre Boulez
___ **IRCAM**	d. F. Richard Moore
___ **MIT Media Lab**	e. Max Mathews

31) The first computer music “piece” realized with Max Mathew’s Music 1 was (In) The Silver Scale (t/f).

32) Name one book title by Pierre Schaeffer and describe its significance (short answer):

33) The Radiophonic Workshop at the BBC created what was called "applied electronic music" for British television and film (t/f).

34) Match the following terms to the most appropriate definition.

___ **pitch**	a. the number of beats per standard unit of time
___ **frequency**	d. a pulse that travels through a medium in all directions
___ **sound wave**	e. a subjective experience of periodic waveforms

35) In his publication, Art of and Apparatus for Generating and Distributing Music Electronically (1897), Thaddeus Cahill explained a sound generation method he would use in an instrument known as the:
a. terpsichord b. singing arc
c. telephonium d. none of the above

36) The end of World War II triggered the wider dissemination of technology used in creating early tape music (t/f).

37) Which of the following compositions are a combination of the concrète and electronische aesthetic (choose all that apply).
a. Ensembles for Synthesizer b. Phoné
c. Gesang der Jünglinge d. My Funny Valentine

38) Music IV-BF, the first software synthesis system (SWSS) to be machine independent (written in FORTRAN), was written by:
a. Vercoe b. Howe and Winham
c. Howe d. Truax

27) A transverse wave is, for example, a plucked string instrument or water—most movement is perpendicular, up and down, to the direction of the wave (t/f).

• BONUS QUESTION •

41) In speaking about the Bell Labs recording, **Music from Mathematics**, Aaron Copland remaked, "The implications are dizzying and, if I were twenty, I would be really concerned at the variety of possibilities suggested." Project what technologies of today might have a similar response from composers of today. Give supportive arguments on your choice of technology(ies).

Introduction to Emu/Quiz 3

MUC 4311/5315-SAIN 11.3.99

The following quiz contains material from assigned reading, listening and class lectures.

• EXAMPLE 1 •

1) The title of this work is _____ and was written by _____.

2) This work belongs to a genre called (choose the most specific answer that applies):
   a. computer music b. electroacoustic music
   c. tape music d. live/electronic music

3) This composition was entirely realized on IRCAM's VAX 11/780 running the following software (choose all that apply):
   a. Digital Performer b. Chant
   c. FORMES d. MAX/FTS

• EXAMPLE 2 •

4) This composer of this work is:
   a. Karlheinz Stockhausen b. Iannis Xenakis
   c. Roger Reynolds d. Neil Rolnick

5) This piece was created with a computer system called GROOVE (t/f).

6) The title of this composition is _____ .

7) The composer founded the Centre d'Etudes de Mathématique Automatique Musicales (CEMAMu) in Paris, France (t/f).

• EXAMPLE 3 •

8) The title of this work is _____ and was written in the year _____ by _____ (composer).

9) This work is for _____ and computer tape.
   a. violin b. viola
   c. cello d. kazoo

10) The computer tape portion of this work was primarily created with a Macintosh/MIDI configuration as well as limited use of Csound (t/f).

• EXAMPLE 4 •

11) The title of this work is _____ .

12) The acoustic musical instrument used in the work is the:
   a. oboe b. violin
   c. flute-o-phone d. bassoon

13) James Mobberly is the composer of this work (t/f).

14) The composer states that this work "utilizes a technique for interactive computer music know as the Virtual Instrument Paradigm which treats the computer as an integral part of the musical instrument." Discuss this concept citing additional projects known to you that utilize similar paradigms, and list their creators (short answer).

• EXAMPLE 5 •

15) The title of this composition is:
   a. La disparition de l'azur
   b. Chor der Waisen
   c. ElectriCity
   d. Alias

16) The author of the work is _____ .

17) This work is based on the text "Restore, restore my heart again" from a love song by Sting (t/f).

• EXAMPLE 6 (not on listening list...perhaps unknown) •

18) Briefly describe this work and what possible compositional techniques may have been used in its creation; give a probable composer for this work (short essay):

• ADDITIONAL QUESTIONS •

19) The following are alternative controllers (circle all that apply).
   a. Violatto
   b. Thunder
   c. Synthophone
   d. Earthquake
   e. Radio Baton
   f. Contact

20) The Very Nervous System analyzed video images of a performer's movement and translated them into _____ .

21) The Multiple-Touch-Sensitive-Keyboard was developed by Bob Moog…
   a. and licensed by Sequential Circuits
   b. was an immediate commercial success
   c. in 1991 after nearly 14 years of development
   d. to be part of the Modular 15 series of synthesizers

22) Tod Machover wrote a hyperinstrument work for virtuoso cellist Yo-yo Ma called Begin Begin Once More (t/f).

23) Composer Morton Subotnick has used software to track a performer's actions to control devices in his operatic version of:
   a. Ascent into Air
   b. Jacob's Room
   c. After the Butterfly
   d. Before the Butterfly

24) Xenakis started a pedagogy satellite to CEMAMu called:
   a. UPICentre
   b. Institute de UPIC
   c. Les Ateliers UPIC
   d. UPIC WEPIC

25) A Hyperinstrument is the refinement of a performer's actions to focus the musical result (t/f).

26) The _____ was an unsuccessful product for Mattel but of great interest as an alternative controller to musicians.
   a. Crackle Box
   b. Power Glove
   c. Lady's Glove
   d. Very Nervous System

27) While in the "New Wild Horse Reservation Ensemble," Joan LaBarbara extended her awareness if timbre and vocabulary (t/f).

28) EIS was developed by Oliveros in the mid-1960s to extend, enhance and transform her improvisations on accordion by controlling digital signal processors via foot pedals and switches. EIS is an acronym for:

_____

• BONUS •

35) "The most interesting music is generally going to be by people who have taken the design of their instruments into their own hands"(Paul Lansky). If you could design your own instrument what would it do and how would it accomplish the task(s).

Introduction to Emu/Quiz 4

MUC 4311/5315-SAIN 11.22.99

• EXAMPLE 1 •

1) The title of this work is _____ .

2) This work was composed in the year:
   a. 1986 b. 1985
   c. 1886 d. 1997

3) Neil B. Rolnick is the composer of this work (t/f).

4) This composition represents an exploration of a real-time computer music system using (chose the best answer):
   a. Macintosh and MIDI b. yahaSALmaMAC
   c. IBM PC and MAX d. Kyma System

• EXAMPLE 2 •

5) The title of this work is _____ and was written by _____ .

6) This work belongs to a genre called (choose the most specific answer that applies):
   a. computer music b. electroacoustic music
   c. tape music d. live/electronic music

7) This composition was realized using MAX to digitally transform and process the following sounds (choose all that apply):
   a. flute b. harp
   c. guitar d. motorcycle

• EXAMPLE 3 •

8) The title of this work is _____ and was written in the year _____ by _____ (composer).

9) This work was created using a computer synthesis process called:
   a. linear predictive coding b. phase modulation
   c. granular d. frequency modulation

10) Briefly describe the programmatic idea behind this composition as stated in the program notes.

• EXAMPLE 4 •

11) This work is a prime example of:
   a. computer generated composition b. computer assisted instruction
   c. computer automated tone production d. MIDI

12) The ensemble is a (choose one):
   a. brass quartet b. woodwind quartet
   c. string quartet d. kazoo quartet

13) Quartet No. 4 is subtitled the _____ Suite and was partly designed by _____ in the year _____ .

• EXAMPLE 5 •

14) The title of this composition is:
   a. Stria
   b. The Blazing Macaw
   c. Amalgam I
   d. idle/chit-chat

15) The author of the work is _____ .

16) As stated in the CD liner notes, the work was created using software called:
   a. SAL
   b. FOIL
   c. HMSL
   d. none of the above

17) The composition is for harpsichord and tape (t/f).

• EXAMPLE 6 (not on listening list...perhaps unknown) •

18) Briefly describe this work and what possible software and compositional techniques may have been used in its creation; give a probable composer for this work (short essay):

• ADDITIONAL QUESTIONS •

19) Iannis Xenakis coined the term _____ music in 1956 to describe music based on the laws of probabilities and the laws of large numbers (circle one):
   a. stochastic
   b. algorithmic
   c. supernumeral
   d. experimental

20) Earth's Magnetic Field (Dodge, 1970), work whose pitches and rhythms were taken from "Bulletin No. 8" of the National Oceanic and Atmospheric Administration (t/f).

21) In talking about the software HMSL, Larry Polansky states, "Everything is possible, but some things may not be easy" Discuss the possible reasons for this statement and the positive or negative ramifications (short essay).

22) Richard Teitelbaum developed PCL (Patch Control Language) as an object-oriented language used to design interactive music environments for his compositions Concertino and Ripieno and Solo for 1 Piano (t/f).

23) Laurie Spiegel designed or helped design the following (circle all that apply):
a. alphaSyntauri system b. Intelligent Musical Instrument
c. Interactive Music Processor d. Music Mouse

24) No World Order (Todd Rundgren), allows the user direct control of the tempo, mood, mix, and musical events during listening (t/f).

25) Felix Hess designed machines based on the interactivity of insects in several projects called (chose all that apply):
a. Electronic Sound Creatures b. Jumping Sound Creatures
c. Moving Sound Creatures d. Static Sound Creatures

26) Michel Redolfi wrote underwater pieces where audiences float and dive in the ocean or a pool while listening to his music (t/f).

27) Barry Truax developed the POD software where POD stands for:
a. Pitch Oscillation Depth b. Poisson Distribution
c. Portemento Delay d. Purple and Orange Duck

28) Joel Chadabe amassed the "world's largest collection of Moog sequencers under one roof" at SUNY Stony Brook (t/f).

29) Started at Mills College in California, the League of Automatic Music Composers developed interactive composition via computers and was later known as _____ .

30) In 1993 Morton Subotnick designed the first musical composition created specifically as a multimedia CD-ROM which allows the user to select the order of sections and visuals; this work is titled (choose one):
a. Hummingbirds and Butterflies b. Jacob's Room, Part II
c. The Wild Bull d. All My Hummingbirds Have Alibis

31) HMSL is an acronym for Heuristic MIDI Signal Language (t/f).

• BONUS •

32) Herbert Brun states, "I write music I don't like so I can learn." Do you agree with the position? Give supporting arguments for your choice stating musical examples that illustrate your thesis.

Introduction to Emu/Final Exam

MUC 4311/5315-SAIN 12.16.99

The following quiz contains material from assigned reading (including liner notes), listening and class lectures.

• EXAMPLE 1 •

1) The title of this composition is:
   a. La disparition de l'azur b. Chor der Waisen
   c. ElectriCity d. Alias

2) The author of the work is _____ .

3) This work is an interpretation of the duality of outer and inner existence through the "life, music and destiny of Renaissance composer Gesualdo da Venosa" (t/f).

• EXAMPLE 2 •

4) The title of this work is _____ and was written by _____ .

5) This work belongs to a genre called (choose the most specific answer that applies):
   a. computer music b. electroacoustic music
   c. tape music d. live/electronic music

6) This work is based upon beliefs/mythology from the following tradition:
   a. Persian b. Roman Catholic
   c. Kabbalistic d. Buddhist

• EXAMPLE 3 •

7) The two Pierres that collaborated on this work have the last names of:
   a. Henry & Schaeffer b. Piper & Rabbit
   c. Schaeffer & Garrard d. Beaucamp & Henry

8) This piece was created with tape manipulation (t/f).

9) This excerpt is from a larger work entitled Symphonie pour un Homme Seul; the correct movement title and year of composition is:
   a. Eros (1961) b. Exotica (1958)
   c. Erotica (1952) d. Eroica (1806)

• EXAMPLE 4 •

10) This work uses the following jazz classic as the basis for a series of intelligent interactive computer musical processes:
   a. Stormy Weather b. Girl from Ipanema
   c. My Funny Valentine d. Stella by Starlight

11) This piece was created with a computer program called "M" (t/f).

12) The composer of this composition is _____ .

• EXAMPLE 5 •

13) The title of this composition is:
   a. The Flaming Parrot
   b. The Blazing Macaw
   c. Amalgam I
   d. Turenas

14) The author of the work is _____ .

15) This work was created using software called:
   a. MAX
   b. YahaSALmaMAC
   c. HMSL
   d. None of the above

16) The composition is for piano with live interactive accompaniment (t/f).

• EXAMPLE 6 •

17) This composer of this work is:
   a. Neil Rolnick
   b. Roger Reynolds
   c. Iannis Xenakis
   d. Karlheinz Stockhausen

18) This piece was created with a computer system called UPIC (t/f).

19) The title of this composition is _____ .

• EXAMPLE 7 •

20) The title of this composition is:
   a. some^more^darn^chatter
   b. just_more_idle_chatter
   c. Notjustmoreidlechatter
   d. Idle Chatter

21) The author of the work is _____ .

22) This work belongs to a genre called (choose the most specific answer that applies):
   a. concrète music
   b. computer music
   c. acousmatic music
   d. electroacoustic music

24) This work is one of a series based on the human origin of electronic sounds (t/f).

• EXAMPLE 8 •

25) The title of this composition is “The Wild Bull” (t/f).

26) The author of the work is _____ .

27) This work was composed using voltage controlled synthesizer modules build by noted electronic music pioneer:
   a. Bob Moog
   b. Donald Buchla
   c. Tom Oberheim
   d. none of the above

• EXAMPLE 9 (not on listening list...perhaps unknown) •

28) The most probable composer of this work is:
   a. Neil B. Rolnick
   b. James Paul Sain
   c. Barry Truax
   d. John Adams

29) What possible compositional techniques, hardware, and software were used in the realization of this work. Use musical examples to illustrate your points (short essay).

• ADDITIONAL QUESTIONS •

30) HPSCHD by John Cage with Lejaren Hiller, was for simultaneous yet unsynchronized, non-interactive performances utilizing seven harpsichords at different tempos with Hiller's _____ .
   a. 1 tape b. 52 tapes
   c. 51 tapes d. 101 tapes

31) Iannis Xenakis founded the Centre d'Etudes de Mathématique Automatique Musicales (CEMAMu) in Berlin, Germany (t/f).

32) The first computer music "piece" realized with Max Mathew's Music 1 was (In) The Silver Scale (t/f).

33) The Radiophonic Workshop at the BBC created what was called "applied electronic music" for British television and film (t/f).

34) Match the following centers for computer music research and a founder/director or researcher associated with the center (select the appropriate letter and place in the space before the center).

___ **CCRMA**	a. Barry Vercoe
___ **IRCAM**	b. John Chowning
___ **CARL**	c. Pierre Boulez
___ **Bell Labs**	d. F. Richard Moore
___ **MIT Media Lab**	e. Max Mathews

35) Name one book title by Pierre Schaeffer and describe its significance (short answer):

36) In his publication, Art of and Apparatus for Generating and Distributing Music Electronically (1897), Thaddeus Cahill explained a sound generation method he would use in an instrument known as the:
a. terpsichord b. singing arc
c. telephonium d. telharmonium

37) Name the five basic tape manipulation techniques.

1) _____

2) _____

3) _____

4) _____

5) _____

38) Come Out was composed by _____ .

39) What instrument arrived at the Columbia-Princeton Electronic Music Studio in 1959? _____ .

40) The end of what major world political event triggered the wider dissemination of technology used in creating early tape music?
a. Korean War b. World War I
c. World War II d. Viet Nam

41) Déserts, for tape and orchestra, was written by Edgard Varèse in the year:
a. 1934 b. 1944
c. 1954 d. 1964

42) Kontakte, by Karlheinz Stockhausen, expanded the idea of tape music with the addition of live elements to his work (t/f).

43) A loudspeaker orchestra designed by François Bayle was called the _____ .

44) Periodic musical sounds are made up of harmonically related frequency components (t/f).

45) Match the following terms to the most appropriate definition.

___ **pitch**	a. reflected wave
___ **periodic**	b. time between beats
___ **frequency**	c. a pulse that travels through a medium in all directions
___ **period**	d. number of beats per standard unit of time
___ **echo**	e. a subjective experience of periodic waveforms
___ **sound wave**	f. constant vibration rate

46) The Radio Baton is an alternative controller (t/f).

47) Tod Machover wrote a work utilizing a "hyperinstrument" for virtuoso cellist Yo-yo Ma called Begin Again Again (t/f).

48) Iannis Xenakis coined the term algorithmic music in 1956 to describe music based on the laws of probabilities and the laws of large numbers (t/f).

49) Joel Chadabe purchased the first Synclavier, but without the (choose one):
a. foot pedal assembly b. computer processor
c. keyboard/control panel d. video display

50) Felix Hess designed machines based on the interactivity of insects in several projects called Dancing Sound Creatures (t/f).

51) The first partial is also known as the (choose one):
a. third over partial b. fundamental
c. undertone d. second overtone

52) Helmholz wrote a book to describe the use of sine sums in the representation of sounds called:
a. On the Use of Frequency Modulation in Representing Complex Timbres
b. On the Representation of Musical Gestures Through Wavelet Analysis
c. On the Sensation of Pitch as a Psychological Basis for Mental Evaluation
d. On the Sensation of Tone as a Physiological Basis for the Theory of Music

53) In equal tempered tuning the frequency ratio between ascending semitones is:
a. 1/12 b. 1/1.059463
c. 1/.0022727 d. 1/3.1416

54) Barry Truax developed a system called _____ to control granular synthesis in real-time (thus making experimentation practical):
a. PODX b. Csound
c. TransMODulaTOR d. POD

55) Richard Teitelbaum developed, PCL - Patch Control Language, as an object-oriented language used to design interactive music environments for his compositions (circle all that apply):
a. Piano Solo for KIM-1 b. Solo for 100 Pianos
c. Concertino and Ripieno d. Concerto Grosso

• BONUS QUESTION •

Jean-Claude Risset states, "The easier a system is to use, the more limited are its possibilities" and Larry Polansky states, "Everything is possible, but some things may not be easy." Discuss why these statements are true in relation to your final project (short essay).

Have a great Winter Break!

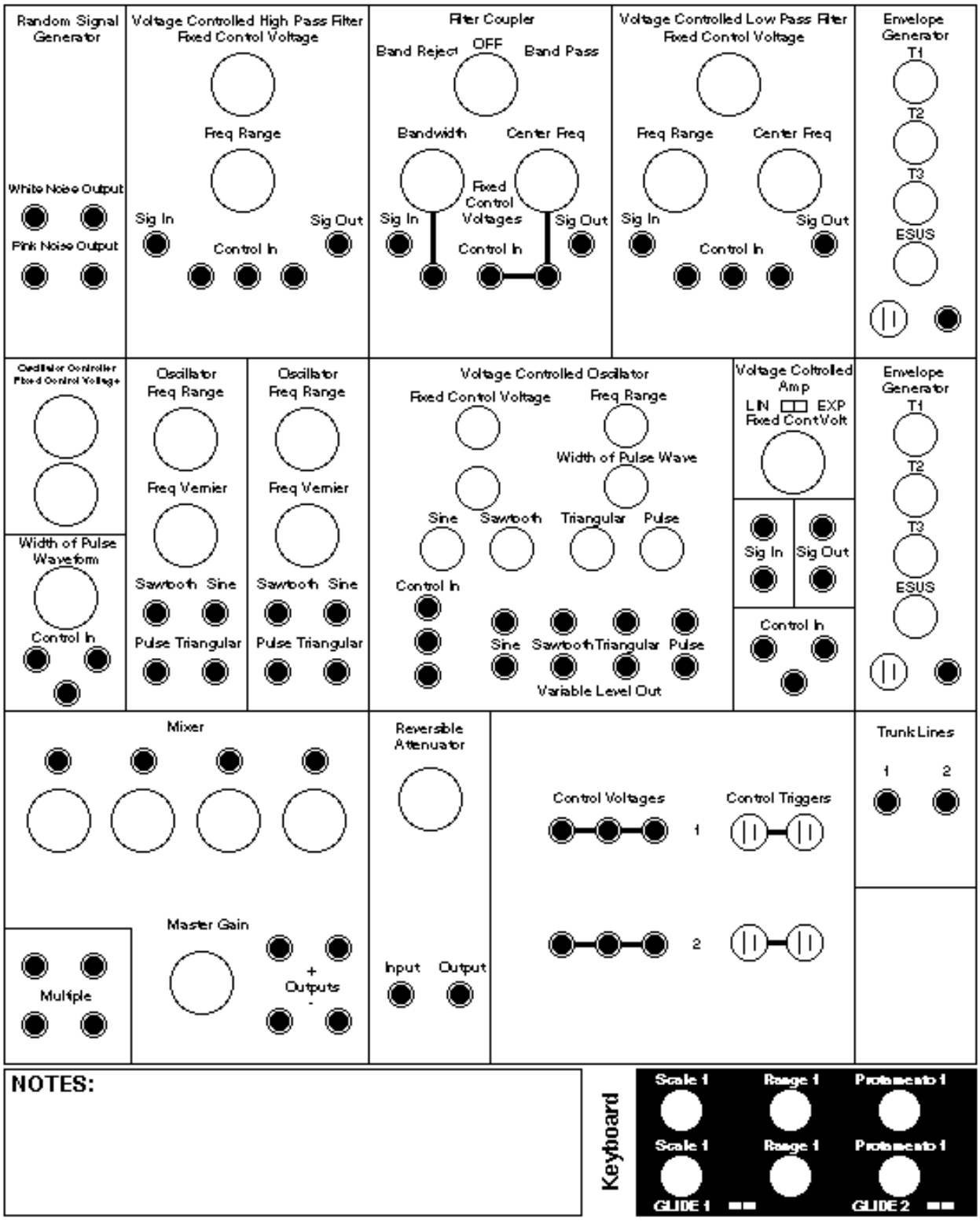
Check here if you'll be in the MUC4401/6444 class next semester ❒

Contact information should your work be chosen to be on the 9th Annual Florida Electroacoustic Music Festival		
address:		
city:	state:	zip:
phone:		
email:		

PATCH DIAGRAM

FEMS R.A. Moog Model 15 Synthesizer

PATCH: _____ DESIGNER: _____



NOTES:

Project Critique

MUC4311/5315 • Introduction to Electroacoustic Music

Project Title:	Composer:

1. Application of Technique /Craft Assigned ____ Project Grade ____

Comments:

2. Demonstration of Aesthetic ____

Comments:

3. Artistic Merit ____

Comments:

Suggestions and Other Thoughts:

• ASSIGNMENT NO. 1 •

Poèm Électronique (1958), Edgard Varèse (1885-1965) CD-506
Erotica from "Symphonie pour un Homme Seul" (1952),
Pierre Schaeffer (1910-) & Pierre Henry (1927-) CD-535
Déserts (1949-54), Edgard Varèse (1885-1965) CD-2180
Sonic Contours (1952), Vladimir Ussachevsky (1911-90) CD-1988
Come Out (1966), Steve Reich (1936-) CD-101
Fontana Mix (1958), John Cage (1912-92) L-5728
Ensembles for Synthesizer (1964), Milton Babbitt (1916-) L-7100
Artikulation (1958), György Ligeti (1923-) CD-520
Concrete PH (1958), Iannis Xenakis (1922-) CD 1310
Collage #1 ("Blue Suede") (1961), James Tenney CD 1379
Projection Esemplastic for White Noise (1964), Joji Yuasa (1929-) CD 1305
I of IV, Pauline Oliveros (1932-) CD 2332
Chef d'oeuvre (1967), Jon Appleton (1939-) CD 1255
Funktion grau, Gottfried Michael Konig CDD 313
Silver Apples of the Moon, Morton Subotnick (1933-) CD 2326
Forbidden Planet, Overture, Louis and Bebe Barron CD 2352
Thema - Omaggio a Joyce, Luciano Berio CD 2392

• ASSIGNMENT NO. 2 •

Sud (1985), Jean-Claude Risset (1938-) CD 510
Stria (1977), John Chowning (1934-) CD 511
Roundeley (1985), Charles Dodge (1942-) CD-498
Phosphones (1971), Emmanuel Ghent (1925-) CD 496
Modalities (1989), Joel Chadabe (1938-) CD 531
Just-more-idle-chatter (1987), Paul Lansky (1944-) CD 530
Jacob's Room, part I (1986), Morton Subotnick (1933-) CD-527
Rol'em, Chris Brown (1953-) CD 1380
Transfigured Wind IV, Roger Reynolds (1934-) CD 506
Memorias, Ricardo Dal Farra (1957-) CD 897
Scambi, Henri Pousseur CD 2343
By heart, Rachel McInturff CD 1319

• ASSIGNMENT NO. 3 •

Mycenae-Alpha (1978), Iannis Xenakis (1922-) CD 506
ElectriCity (1991), Neil Rolnick (1947-) CD 1264
The Hands (1986), Michel Waisvisz (1949-) CD 507
Jardin Secret 1 (-), Kaija Saariaho (1952-) CD 499
Improvisation on Strange Attractors v1.0b (1990), Stephen David Beck CD 783 v.1
Momente (1962-64), Karlheinz Stockhausen (1928-) L-1495
Chor der Waisen (1985), John Melby (1941-) CD 521
Synchromisms No. 9 (1988), Mario Davidovsky (1934-) CD 496
La disparition de l'azur, Erik Mikael Karlsson (1964) CDD 174
Alias (1990), Ake Parmerud (1953-) CDD 173
Hard Cash (and small dreams of change), Katherine Norman CD 1383

• ASSIGNMENT NO. 4 •

Quartet No. 4 for strings, 'Illiac Suite' (1957) III. Experiment III
Allegro con Brio, Lejaren Hiller (1924-94) CD-524
What use is this? (1985), Neil Rolnick (1947-) CD 533
Golem 1 (1987), Richard Teitelbaum CD 533
Paraptra (1991), Cort Lippe (1953-) CD 783 v.2
Spontaneous Combustion (1991), James Mobberley CD 783 v.1
Exile and Life Close to the Horizon: excerpt (1990), William Brunson (1953-) CD 749
Time to Go (1977), Laurie Anderson (1947-) CD 1312
The Blazing Macaw (1992), Charles Norman Mason CD 783 v.3
Appalachian groove I, Laurie Spiegel CD 1312
Not so heavy metal, Paul Lansky (1944-) CD 10322
Riverrun (1986), Barry Truax (1947-) CD 10322

Letter To A 25-Year Old Electroacoustic Composer

Barry Truax

Presentation to L'Academie Internationale de Musique Electroacoustique
Bourges, France, June 1998

So, this field we call electroacoustic music is celebrating its first half century, just as I did recently. While I cannot say that I actually grew up with this music, I discovered it in my early twenties (1969), and so I have participated in a good 25 years of its development. I've also heard a lot about the previous 25 years, often from the practitioners themselves, many of whom have unfortunately passed away in the meantime. With any luck I may still have another 25 years, and then you will be in my place now, and I wonder what choices you will have made, and what you will be writing to the next generation?

Where Have We Been?

It is perhaps a cautionary tale that I have to relate to you that someone such as myself, having worked in the field for only a bit more than 25 years, starts being regarded as a 'pioneer' or 'senior artist' and is expected to comment sagely on the whirlwind of developments that have occurred over that period. Every five years seems to constitute a 'generation' and after five of those cycles one starts sounding like a colorful 'old-timer' spinning yarns that begin with 'I remember when'. The same thing may happen to you, only sooner since the speed of technological change seems to be accelerating.

The sheer pace of development, and everyone's inability to keep abreast of it, seems to produce a lack of perspective on either where we've been (except to regard it as inevitably primitive compared to where we are) or where we're going (except for an uneasy sense of it being, as Miranda might have put it, a 'brave new world' that has such machines in it!). A more positive result of this situation is that there is a strong sense of a thriving international community, if only because we need to co-operate and help each other deal with forces that are beyond our control. If you contribute to this community, it will give you a great deal of support in return.

Just what are the forces that have propelled our field so strongly? And why is the mood almost always 'up beat' - at least in comparison to our instrumental composing colleagues where the phrase 'squabbling over crumbs' usually comes to mind. Early on (and here comes the 'I remember when' part) I think the core of the energy was in the interdisciplinary confluence of art, technology and research. Our work was mainly in the labs, whether universities, research institutes, radio stations or industry, because this is where the machines were. Translating musical thinking into these environments was awkward and challenging, both because it revealed the woeful inadequacy of received musical theory, and because there was so much to learn about acoustics, psychoacoustics, audio engineering, computer programming, and so on. In order to work with computers, practically everyone had to become a programmer, or at least work with one, as there were no standard tools and few texts. The advent of the mini-computer, and then the micro-computer in the 1970s, brought that research and its tools into the realm of the individual and the music studio where personal models could be explored. In contrast, you're more likely to use the same software and hardware as most of your peers - how has that come about?

The principal difference in the field now to what it was then lies in the commercial applications of digital technology. Whether the market is niche or mass in scope, its force is inescapable as it generates most if not all of our tools today, with all of the sense of 'mixed blessing' that entails - near universal accessibility (undeniably a 'good thing') to the same tools (something I have more trouble with). Not only has the public become saturated with the products of the digital domain (from car alarms to the internet), but so have the musicians (I've already encountered young composers your age who are so comfortable in the digital domain they claim not to know how to use a tape recorder!). But for me, the digital domain means something totally open-ended, limited only by my ability

to program compositional ideas - to you it already means configuring products that are industry standards. In fact, I've never really used any one else's software for composition (which makes me a vanishing breed); you'll probably never need to develop your own at all. Neither path seems preferable, but I wonder where the new ideas will come for you?

In my own experience - which may or not be instructive for you - the new ideas (and the music they lead to) are what have 'hooked me' on being an electroacoustic composer. When the use of any technology gives me new perceptual experiences and new compositional ideas, things that could not be achieved in any other way, then its use seems justified and the result creative. In my own field, sound synthesis and composition, what constitutes new and old ideas is particularly clear. Preset timbres and sound effects - and the distancing effect they have on me - are the hallmarks of the marketplace's influence in terms of sound design, as is music based on instrumental concepts of harmony and orchestration in terms of composition. What I value most about my creative work are the pieces which could not even have been imagined by me beforehand, let alone realized, without the use of technology.

Some of the key influences that have led me in this direction are the interactive, quasi-improvisational aspect of the analog studio, the open-endedness and precision of software development, particularly when combined with feedback from its musical use, and the aural experience of the complexity of the soundscape. All three of these areas currently seem to be on the margins of electroacoustic music as practiced today. However, each area has stimulated my musical thinking, usually in ways that bypass words, intertwining sound and structure, aural perception and cognitive understanding, emotion and thought, in complex ways. I know you cannot turn back the clock, nor should you try, but I hope that these three areas - interactivity in the analog tradition, open-endedness in software design, and the complexity of the acoustic world - will continue to inspire you as much as they have me.

Where Are We Now?

Well, the quick answer is "on our own" and maybe that's where we should be. We're not alone of course - I've already mentioned the supportive international community which has developed its own infrastructure. I think that the 20th century in the arts has been unique in that its traditions have fragmented into separate, and largely parallel streams. For instance, after 50 years, it seems quite clear that the "classical music" establishment has done practically nothing to embrace electroacoustic music as part of its ongoing development. There are occasional exceptions, but in general, the institutions of the symphony, opera and chamber music have ignored our art form. By the time you're my age, I expect you'll find these groups still playing more or less the same repertoire as they do now, or at least music that sounds quite similar. As a result, you will probably feel excluded from their definition of culture.

The electroacoustic community is supported mainly by its own practitioners as a kind of "parallel culture", the best result of which is that it is vibrant and open-ended, the less fortunate aspect being that it can be insular and not very self-critical. Being a member of this community, like any community, can be very comforting, but it can also lull you into the complacency of talking to (and composing for) only like-minded colleagues who accept what you do simply because it's like what they do, and not because you actually have anything important to say. Believe it or not, the technical and stylistic questions which provoke the most debate in our community, and fill the texts and research papers, have no importance for our audience (assuming we really hope to have any). You cannot expect them to be interested in what seems to them to be your esoteric concerns. Ask yourself, instead, if what you are doing answers any of their concerns or life issues. That may seem to be too much to expect, but in fact, all of the great art of the past in every culture has done just that, and ultimately we cannot expect to be judged by any lesser standard.

An equally serious aspect of electroacoustic music today is that it essentially doesn't exist in terms of the mass media. Hence the public has no awareness of our work, unless they stumble across one of our practitioners or happen to like visiting fringe subcultures. Given that technology can be "trendy", I've always been rather surprised by this lack of

interest, but the root causes seem to be much deeper. The fact is that the mass media are dominated by commercial forces, and since no one is making enough money from this music, we are destined to be ignored. And because we lack the promotional apparatus of the "culture industry" - publishers, agents, galleries, impresarios, and producers - we're not going to get much "arts" coverage either.

The most troubling aspect of this commercial force, at least for me, is the current contest for what is going to define culture. Is it the commercial model - culture as what sells - or the public one - culture as what has social value? One only has to look at the relative strengths of the private and public spheres in North America and Europe to see, first of all, different traditions in this definition, and secondly, the inexorable ascendancy of corporate control in the face of which government has dwindling influence. Computer music, in particular, (a term that is likely to fade away as the distinction becomes less and less meaningful) will continue to be a site defined by this struggle because of it ambiguous position between industry and culture. The personal version of this dilemma - which "god" will you serve? - may well be one of the most difficult choices you will have to make.

Most young composers seem to place their hope for technological development in the "trickle down", effect - from the research lab to the manufacturers to the software developers to us - in order to get more and better tools (or "toys", with its sexist overtones). This model has its practical benefits for which I am often grateful (laser printers, CD burners, DAT machines and the internet certainly seem indispensable today), but I don't think it is the main route by which music as public culture will develop. For one thing, the rule will always be "the more you have, the more they have", with "they" being those in corporate control of both the production and dissemination of cultural products. In other words, our increased access to technology provides a wonderful opportunity to be able to produce and distribute our own work, but have no illusion that originality, artistic validity, or access to an audience are made any easier than before.

So, you can see that I have no "homestead" to pass on to you, just a niche carved between the borders of popular culture, artistic tradition, and industry. We have links to all three of these areas and you will have to find your own way of balancing their competing forces and not becoming overwhelmed by their regimes. Please don't make the mistake of thinking of electroacoustic music as either "high art" or "fringe pop". Those high and low culture, high-brow/low-brow distinctions have little relevance today and will probably have even less in the future. Electroacoustic music has grown out of the 20th century "tradition" of experimental art and is neither elitist nor populist. I suggest you worry less about where it fits socially, and concentrate more on what it means for you, which should be a means for personal creativity - something that seems increasingly elusive in a commodity driven world. In fact, given the lack of cultural, media or commercial support you can expect if you follow the creative path, you'll have to learn the hardest lessons of any art - your work has to be worth doing for its own sake, and you can't imagine living without doing it.

Where Are We Going?

I doubt that anything I might predict about the future, as amusing as that exercise might be, would have any particular validity, or at least enough to merit your attention. Whatever we are presented with in the future, I know that I will tend to evaluate it in terms of what it contributes to my creative process and how it extends my musical thinking. On the broader social level, I will look at how it supports either the corporate or public definitions of culture, the latter being the only one that supports a broader range of 'voices' to emerge. I am personally in a privileged position at a public university to be able to devote myself exclusively to the pursuit of what I perceive to be the public good. You may not be so fortunate. However, I sense among people of your generation a willingness or at least an ability to live with less single-minded focus and to function in apparently contradictory situations with different value systems - what is commonly called 'postmodern' culture. Musically, you seem comfortable in actively pursuing, not just consuming, a pluralism of styles and media - world music one day, your "garage band" the next, pop music on weekends, and maybe some electroacoustic music in your spare time -

not to mention your "day job". That alone should add a new level of complexity to our already complicated sense of culture in the next century.

On the theoretical side, I've imagined some paradigm shifts (Truax, 1992) which I think are long overdue, mostly characterized by a new definition of complexity and a greater degree of what is now being called "ecological validity". That means, we should constantly test our results against the complexity of real-world situations, starting always with perception. For too long we've been satisfied with sounds that are pale imitations of those in the real world, and far too proud of our theories to admit what our ears should have told us: that the sounds and communication systems of the natural world - particularly the soundscape - are far more complex than what we are currently producing in our music. Too often reductionistic theories have convinced us that systems are linear, parameters are independently controllable, and human responses predictable. Fortunately such theories are coming under greater critical scrutiny as they increasingly prove themselves to be inadequate to explain phenomena in the real world. But in your own life, try to listen as openly and attentively to the soundscape as you do to the music you're imposing on it. Find a balance between listening and soundmaking, and be prepared to be humble.

I still maintain that theory should follow practice, and that each should be informed by the other. But even if we manage to develop better intellectual models in order to understand the world and our place within it, artistic practice should continue to go beyond even the best models and have an aura of the inexplicable and the evanescent. So, avoid the latest "bandwagon", become informed to the best of your ability, but be prepared to go the final steps on your own with only your own intuition as a guide - most of the time, you will eventually be proved right! But if you're not, try to have the maturity to learn from your mistakes.

So, in the end, what it all comes down to is not the brave new world of the machine that promises to make everything possible, or the various environmental or economic crises that will make life difficult for you, but simply finding something inside yourself that is necessary. This is very old, and not very original advice, but we have such interesting ways of rediscovering its truth today! How ironic that something external like technology and software might eventually teach us something about ourselves! Don't be misled by the merely rational aspect of technology to think that electroacoustic music is just an esoteric mind game for producing abstract music. If you follow that path, you'll end up sounding like everyone else. Don't be afraid to follow your own passions, your sexuality, your imagination and your spirituality and express them through your music. That will make your music worth listening to, and if you do all that, I'll be very curious to hear what you will have to say after 25 years in the field!

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B. Truax, "Discovering Inner Complexity: Time-Shifting and Transposition with a Real-time Granulation Technique," Computer Music Journal, 18(2), 1994, 38-48 (sound sheet examples in 18(1)).

B. Truax, "Sounds and Sources in Powers of Two: Towards a Contemporary Myth," Organised Sound, 1(1), 1996.