The Mills College Center for Contemporary Music's Seminar in Formal Methods Series: A Documentary Survey

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Abstract—This article documents the history of the Seminar in Formal Methods Series at Mills College, Oakland, California. Inaugurated in 1981, the series was conceived as a forum for the presentation and dissemination of recent developments in several disciplines, such as art and technology, experimental aesthetics and applied formal methods in music. The article includes brief descriptions of each seminar, biographical information about the speakers and a selected bibliography of relevant books, articles and recordings.

I. INTRODUCTION

The Mills College Center for Contemporary Music's Seminar in Formal Methods Series was begun in the fall of 1980 by David Rosenboom and Larry Polansky, who are still the directors. The original motivations for this project, which continue to guide it, include:

* creating a public forum to disseminate ideas in subject areas specifically focused on the relationship of art to technology, especially those that we feel are not given adequate attention
* allowing ourselves, our students at Mills College and members of the San Francisco Bay Area arts community access to direct presentations of state–of–the–art and experimental thought in new areas of musical and technological research
* creating a forum in which residents of the San Francisco Bay Area who are concerned with the relationship of art (especially music) to technology could interact with each other and guest speakers.

The topics on which the seminars have focused usually have been directly related to music and, in particular, to formal methods in the creation of music. However, not all of the speakers have

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been musicians, nor have all of the seminars necessarily mentioned music. A partial list of subject areas covered during the past five years includes:

* electronic systems design
* automated and algorithmic compositional ideas
* artificial intelligence in the arts
* experimental aesthetics
* systems theory
* mathematics
* computer science
* film and the visual arts.

The following document presents a selected historical list of topics that have been offered by the Seminar in Formal Methods Series since its inception. Included are a synopsis of each talk, a brief biographical sketch of each speaker and a select list of references relating to the work discussed.

II. DESCRIPTIONS OF SEMINARS

Morphological Metrics. Larry Polansky, 20 October 1981.

Larry Polansky talked about ways to discuss musical measures of distance. He gave a historical presentation of the types of statistical methods he had used in a program that implemented many of James Tenney's ideas of formal distinction (segregative and cohesive) in music. He then suggested several metrics that might be applied to morphological domains, where the order of parametric profiles is an issue (as is not the case where only non-ordered statistical phenomena are considered).

Larry Polansky is a composer, programmer, theorist, systems designer, teacher, performer and writer whose

work focuses on experimental music composition systems. He is currently a staff member at the Center for Contemporary Music and a faculty member of the Mills College Music Department. He is the co-founder and co-director of the Seminar in Formal Methods Series and director of the Mills College Contemporary Music Ensemble.

Composing with Some Real–Time Instrument Languages. David Rosenboom, 25 November 1981.

David Rosenboom presented several of the real–time interactive computer music composition languages, including PATCH-IV, with whose development he has been closely involved, and focused on his own FOIL (Far Out Instrument Language), the composition and performance language he wrote for the TOUCHE digital keyboard synthesizer. Rosenboom discussed the advanced instrument definition capabilities, stimulus–response environment and algorithmic control of the instrument as well as plans for future developments. He also integrated these implemented ideas with thoughts and projections on the design of real–time music languages in general.

David Rosenboom is a theorist, composer and electronic music instrument designer and one of the pioneer figures in live–performance electronic and computer music. He is currently head of the Music Department at Mills College and director of the Center for Contemporary Music. He has served with Larry Polansky as co-director for the

Seminar in Formal Methods Series since its inception.

The Design of a Combined Pitch and Timbre Scale. David Rothenberg, 1 December 1981.

David Rothenberg discussed many of his ideas regarding theoretical scale design incorporating pitch and timbre, and he suggested formal ways in which his notions of proper and improper scales could be applied to timbral scale generation using a kind of salient–feature axis model. He discussed the ways in which notions of perceptual 'distance' are often altered radically by additions, perturbations and deletions from the combined space, relating this to a notion of combined scalar 'dissonance' and 'resolution'. He gave examples of the types of mappings composers might use in computer applications of these ideas.

David Rothenberg is a mathematician, computer scientist, composer and theorist who has written many articles on the design of formal languages for perception and composition. He has long been aware of the need for a systematic symbolic representation of compositional concepts and procedures; for over 25 years, he has provided radical new ideas to the field.

Computer–Generated Film. Larry Cuba, 28 January 1982.

Larry Cuba showed many of his recent films, all of which involve computer–graphic image generation. He then gave a detailed discussion of new computer–graphics workstation environments including a new, commercially developed workstation which he had recently begun to use.

Larry Cuba is a filmmaker and computer artist who has worked in the field of computer generated film for many years. He was an early student of John Whitney, and since that time Cuba has investigated methods and technologies for complex image generation. His work has been shown internationally.

Algorithmic Compositional Processes and Pitch Isomorphisms. Andrew Newell, 11 February 1982.

Andrew Newell discussed some algorithms he had used for mapping intonational systems, via group theoretical procedures, into a kind of serial compositional procedure. He then played examples of some of the instrumental music he had generated in these ways.

Andrew Newell is a composer, performer, teacher and producer whose interests have included improvisation, algorithmic music and graphic notation. He has received numerous awards for his compositions, and has had his work performed widely in the United States and Europe. He was the co-founder of the New Kanon New Music Ensemble and is currently a member of Earwax Audio Productions in San Francisco, a company specializing in theater and commercial sound design.

Low–Cost Hybrid Control Systems. Darrell Johansen, 25 February 1982.

Darrell Johansen described his prototype for a microcomputer–based system that controlled Serge Modular Systems analog hardware modules. His system made use of a 6502 microprocessor and various I/O (input/output) and scheduling devices that facilitated rhythmic experimentation.

Darrell Johansen is an engineer, programmer and systems designer for Serge Modular Systems in San Francisco. Johansen has designed innovative hybrid control systems (computer control of analog synthesis), as well as several large music software packages for the Macintosh and other computers. He is currently affiliated with Studio Software, a Bay Area–based music software company.

Aural Illusions. Scott Kim, 4 March 1982.

Scott Kim demonstrated some of the aural illusions he had invented, discovered and learned how to perform. Exhibiting visually apparent paradoxes, these aural illusions included such things as the Shepard tone, which he was able to demonstrate on the piano. He also demonstrated several other aural illusions and talked about the ability of the ear and the mind to discern various apparently contradictory phenomena in these illusions.

Scott Kim is an author, visual artist, mathematician and musician who is known for his work in typography and as an illustrator of mathematical and philosophical constructs. His book *Inversions* deals with typefaces that are invertible around a given axis. He was one of the illustrators for Douglas Hofstadter's book *Godel, Escher, Bach*.

Patterns of Knowledge, Part I. Lynx Crowe, 11 March 1982.

Lynx Crowe laid the conceptual foundation for his programming work in the development of computer music languages such as PATCH-IV and MIDAS. Using a broad range of references from systems theory, epistemology, cosmology, philosophy and theories of aesthetics and experimental aesthetics, Crowe raised important questions both about the ways in which users describe their creative and perceptual environment and about the ways in which systems limit, enhance and interact with those descriptions.

Lynx Crowe is a language designer who has contributed to the development of computer music through his long association with Donald Buchla and associates. He has been interested especially in small system computer music systems. PATCH-IV, MIDAS and the recent CHOPS are among the languages he has designed and written.

Some Recent Developments in Computer Music at LucasFilms. Andy Moorer, 18 March 1982.

Andy Moorer demonstrated some of the progress that has been made recently in signal processing, sampling, editing, reverberation, and sound-location techniques at the LucasFilms computer music facilities. He played several examples of recent work created there not only for film but by experimental composers as well.

Andy Moorer has for many years been a leading figure in computer music and has written widely on software synthesis, digital to analog conversion, algorithms for complex timbre synthesis, digital reverberation techniques and other issues. He has worked at CCRMA at Stanford and at IRCAM in Paris and currently is working on digital sound systems for LucasFilms.

The Design of Real–Time Music Languages and a Preview of the Buchla 400. Don Buchla, 1 April 1982.

Don Buchla described and demonstrated his 400–series instrument and its music languages MIDAS and PATCH-IV (developed by him and Lynx Crowe). The 400 series is based on a six-voice digital waveshaping oscillator with arbitrary envelope generation; the software and hardware environment includes powerful instrument definition software, score

editing, sequence definition capability and compositional aids.

Don Buchla has been active for over 20 years as a composer and pioneer in electronic music systems design. Credited for the development of one of the first modular synthesizers, he has continued to create new analog, hybrid and digital instruments. His current interests are languages and systems for performance.

Performance as Language, Language as Performance. Chris Mann, 5 October 1982.

Chris Mann performed, demonstrated and explained his ideas in the use of 'found dialects' and linguistics for compositional purposes. His 'lecture' took the form of a performance, in that he actually spoke in many of the obscure Australian dialects and accents that he was discussing, blurring the distinction (in a rapidly changing way) between the form and the content of the communication.

Chris Mann is an Australian composer and performer whose work explores the boundaries between language and art. He often uses virtuosic explorations of indigenous dialects and vernaculars in radical linguistic and performance situations. Currently he is artist in residence with the Australian Broadcasting Company.

The Sal–Mar Construction. Salvatore Martirano, 18 November 1982.

Sal Martirano gave an extended discussion and live demonstration of his Sal–Mar Construction, which had been set up in the Mills College Concert Hall for a concert later that week. As the Sal–Mar Construction uses over 20 channels of independent sound routing, speakers were suspended throughout the hall to demonstrate this effect. Martirano discussed the synthesis, performance and control methods inherent in the instrument.

Salvatore Martirano is a professor of composition at the University of Illinois and one of the pioneers of live electronic music performance through his Sal–Mar Construction. He is also known as an early experimenter in the area of mixed-media performance through pieces like *L'sGA*.

Patterns of Knowledge, II. Lynx Crowe, 3 February 1983.

Lynx Crowe extended the frame of reference of his previous talk to a more conceptual and speculative application. Drawing upon ideas such as those of G. Spencer Brown, Francisco Varela and others, Crowe explored the concepts of systems which exhibit knowledge of themselves and 'awareness' of higher meta–systems. He related these ideas to the musician's experience.

Musical Applications of the 68000 Microprocessor. Phil Burk, 17 February 1983.

Phil Burk demonstrated and described a small, homemade programming environment and hardware system he had built based on an MC68000 microprocessor chip and inexpensive parts. His system used a Z–80 as a 'front-end' processor for language and terminal interpretation, which sent opcodes to the host 68000. Though his language for the system was based on the notion of 'threaded interpretive languages' (e.g. FORTH), he made several modifications, including a flexible token executive. He then described ways in which the system lent itself to musical experimentation.

Phil Burk is a programmer and electronic designer with a strong interest in user interfaces in computer music. He is a graphics programmer and is affiliated currently with the Center for Contemporary Music in the implementation of HMSL (Hierarchical Music Specification Language).

Timbre Synthesis and Controller for Expressive Playing of Pitch Loudness and Timbre on Computer Instruments. John Snell, 3 March 1983.

John Snell described some experimental devices for use as input structures to various musical parameters and displayed some prototypes. He related his ideas specifically to issues involving world music, notably the music of India and Indonesia.

John Snell, one of the early figures involved in the implementation of powerful mainframe computer music systems, is a researcher in musical applications of digital signal processing and a founding editor of the *Computer Music Journal*. He is working currently for LucasFilms on the ASP project, a sophisticated synthesis, signal-processing and sound-editing facility.

The UPIC System and Other Works. Iannis Xenakis, 9 March 1983.

Iannis Xenakis presented examples and descriptions of his UPIC system, which allows the user to specify various aspects of the micro- and macro-structure of music in a wide variety of flexible and dynamically definable ways. He showed some unusual examples of the ways in which the system functions as a valuable educational tool for young children, and he played the results of their work. He also presented tapes and visual documentation of several of his own new pieces, some of which had been realized with the UPIC system.

Originally trained as an architect, Iannis Xenakis is a composer, theorist and proponent of the application of mathematical models to musical composition. At the time of this seminar, he was a Darius Milhaud Distinguished Visiting Professor of Music at Mills College. He currently resides in Paris, where he is engaged in the design of a digital synthesis instrument whose parameters can be designed and controlled entirely by drawing.

A Comparison of Formal Modelings of Musical Perception and Composition: Tenney, Ames, Polansky, Lehrdahl, Jackendorff *et al.* John Myhill, 31 March 1983.

John Myhill described various computer models of formal perception that he considered important and archetypal in some way. He then compared salient features of each model and suggested changes, refinements and expansions based on his thorough knowledge of the research. His analyses demonstrated a concern and sympathy with the aims and focuses of the modeling procedures. He spent considerable time on the algorithmic compositional experiments of Charles Ames, a colleague of Myhill's in Buffalo, New York, and played some extended examples of Ames's computer-generated instrumental scores.

John Myhill is a mathematician and composer with a long-standing interest in algorithmic and formal processes in music. He has been associated closely with many composers as an educator and theorist and has contributed to the development of theoretical bases for computer music.

Microcomputer Music Network. Jim Horton, 7 April 1983.

Jim Horton explained the design structure and aesthetic philosophy behind the work of the League of Automatic Music Composers, a group of composers (including Horton, Rich Gold, Tim Perkis and John Bischoff) who write and perform complex improvisational music based on the interaction of small computer music systems. In performances by the League, each of the microcomputer systems in use is a hybrid, 'homebrew' collection of various small and inexpensive customized digital and analog circuitry and software. Typically, each composer's programs and sound–producing circuitry reflect his own compositional interests and style. However, the League uses complex 'message–passing' procedures, in which computed data from any 'node' of the network (each of the performers) is made available to the others in raw form, to be transformed and interpreted by them and their computers.

Jim Horton is a composer, performer and theorist. He was a founding member of the League of Automatic Music Composers, a San Francisco Bay Area group involved with interactive microcomputer music systems.

Visual Equivalents in Music. Douglas Hofstadter, 13 May 1983.

Douglas Hofstadter showed numerous examples of his work involving simulating musical forms and processes through visual media. He also gave various examples of work by others who had attempted similar types of experiments, toward both artistic and pedagogical goals.

Douglas Hofstadter is an author and thinker whose book *Godel, Escher, Bach* won the Pulitzer prize. He has become known for his interdisciplinary ideas in music, mathematics, typography, computer science and philosophy. For several years, he was a regular contributor to *Scientific American* with his column "Metamagical Themas".

Understanding Understanding. Heinz Von Foerster, 30 November 1983.

Heinz Von Foerster described his work in systems theory and relationships to aspects of perceptual processes. In particular, he focused on the notion of understanding: how organisms and systems grow to 'understand', and how these same entities perceive (or understand) their own understanding.

Heinz Von Foerster was a founding member of the Biological Computer Laboratory at the University of Illinois, where he (along with Francisco Varela, Humberto Maturana, Herbert Brün and others) helped to develop systematic and visionary modes of describing natural processes in the form of systems theory. He has many publications to his credit and continues to influence the development of systems theoretic notions in the arts.

Advanced Listening Techniques. John Bischoff and Tim Perkis, 8 March 1984.

John Bischoff and Tim Perkis described and played examples of their music. They talked in detail about the technical and artistic histories of their music, from their early work with the League of Automatic Music Composers to the present. Each composer tended to utilize small, inexpensive microcomputer systems of his own design or modification, which were combined with systems of computer-aided composition that, like the hardware, often related to one piece only or to a group of pieces. As a result, these composers' designs emphasized the fabrication of a system (hardware and software) that had general musical implications, but which was used specifically for a given piece of music.

John Bischoff is a composer, performer and electronic musician whose work has been performed internationally. He was a founding member of the League of Automatic Music Composers and continues to influence the San Francisco Bay Area experimental music community.

Tim Perkis was also a founding member of the League of Automatic Music Composers. He is a designer of computer music hardware and software, especially for low–cost stand–alone performance systems. He has been involved recently in the design of interfaces between high-speed digital signal processors and available computer systems.

Small Computer Applications in the Hybrid Electronic Music Studio. Daniel Kelley, 29 March 1984.

Daniel Kelley discussed the design philosophy and practical applications of MASC (Meta–Language for Analog System Control), a FORTH–based music composition language which utilizes analog–to–digital and digital–to–analog conversion to control electronic music instruments. Kelley had previously 'ported'

a version of MASC onto the Center for Contemporary Music's 68000–based HMSL system, and he was able to demonstrate the language in the studio itself. MASC provides the user with simple and extensible (through the FORTH environment) methods of creating envelopes, time–variant control functions of analog parameters, complex sequence definition, editing and execution, and a stimulus–response environment utilizing voltages and pulses (both in and out of the computer). Kelley described the wide use of the language—it has been ported to many small systems of various types—as well as plans for his MIDI (Musical Instrument Digital Interface) implementation.

Daniel Kelley is a composer and electronic systems designer. His hybrid control language MASC, developed at San Jose State University, is widely distributed. Kelley has also been active in the use of small signal processing facilities for microcomputers.

Music and Music Research at IRCAM: Perceptually Based Aids for Composition. David Wessel, 3 April 1984.

David Wessel described two current projects at IRCAM in Paris, which involve composition and psycho–acoustics. The first concerns procedures for timbral mapping and the definition of timbral spaces from which a composer can extract ordered axes for timbral compositional experiments. The second concerns the psycho–acoustic phenomenon known as 'common destiny', or the 'jitter' effect, in which dynamic spectral evolutions seem to have almost hierarchical organization wherein large-scale 'causes' or 'tendencies' can be analyzed from the behavior of groups of individual spectral changes. He described some of the conjectures and data on the perceptual effects of this process and the current thought on its importance in music and perception.

David Wessel is a psycho–acoustician, theorist and composer. A contributor to the field of computer music for many years, he is currently Director of Pedagogy at IRCAM in Paris.

Digital Synthesis in Your Kitchen. Michael Schippling, 12 April 1984.

Michael Schippling talked about the uses of inexpensive high technology in the design of high–performance experimental electronic music systems. In particular,

he discussed and demonstrated his use of FORTH on a commercially available, but highly modified, home computer to control various signal–processing and sound–synthesis gear, the latter including some inexpensive digital–filter and voice–synthesis chips.

Michael Schippling is an instrument designer, programmer, performer and composer who is known in the San Francisco Bay Area for his radical use of home–built electronics. His professional affiliations have included research and engineering positions at the Exploratorium in San Francisco and the University of California at Santa Cruz Electronic Music Studio.

The Apple Macintosh as Composer's Tool. Scot Gresham–Lancaster, 18 September 1984.

Scot Gresham–Lancaster explained his applications of the Macintosh computer to musical composition. He disucssed at length his own manipulation of the Macintosh's sound–producing hardware to create scales and entire compositions in different intonations and tunings, and his projected use of the mouse to trigger musical processes represented by icons.

Scot Gresham–Lancaster is a composer and electronics designer. In recent years, he has worked extensively with the Apple Macintosh computer, developing tools for its use as a live–performance instrument. Currently, he is Technical Director of the Center for Contemporary Music at Mills College.

Performer/Microcomputer Interaction within the Context of Improvisation and Composition. George Lewis, 4 October 1984.

On the evening before his concert with composer David Behrman, George Lewis demonstrated his personal computer system, which is capable of listening, and responding, interactively to his improvisations on trombone. Lewis's programs are written in FORTH to drive a general MIDI environment, and they use a Gentle Electric pitch–to–voltage converter/envelope–follower for input. Each of the many programs that Lewis wrote for these improvisational environments had a unique 'personality', or musical style, determined by the parameters of its response to Lewis's playing. He described the ways in which many of these software modules were modeled after the musical personalities or improvisers with whom

he had performed including Derek Bailey and J.D. Parran.

George Lewis is a composer and performer who has served as music program director of the Kitchen Center for Video, Music, Dance and Performance Art in New York City and has been active in new music as composer, improviser and interpreter. He has been a research fellow at IRCAM in Paris and is currently at STEIM in the Netherlands, where he continues to work in computer–controlled interactive improvisation systems.

Concert/Workshop: New Text/Sound Compositions. Charles Amirkhanian, 13 October 1984.

Charles Amirkhanian presented and discussed his recent work, some of which had been completed in the studios of the Center for Contemporary Music in collaboration with CCM recording studio engineer Richard Povall. These studio sessions were open to the public and attended by students. His program included *Gold and Spirit*, a commission from the Los Angeles Olympics Arts Festival, and *Martinique and the Course of Abstractionism*, which he composed and realized at the CCM. Amirkhanian described his general procedures of composition and the ways in which he deals with text, text/sound and the style he has dubbed 'Lexical Music'.

Charles Amirkhanian is a progenitor of text/sound music and a historian and archivist of twentieth–century music. He has performed his music all over the world and has been active in the development of public recognition for many avant–garde artists. Currently, he is the music director of KPFA/Pacifica Radio.

The Evolution of Music and the Perception of Time. Ted Coons, 16 October 1984.

Ted Coons's seminar demonstrated the ways in which the results of psycho–acoustic tests for musical 'interestingness' are determined to a certain extent by changes in musical taste, culture and history. He performed several experiments on the audience that related the perception of elapsed time to degrees of order and complexity in the sonic material, and he described laboratory results of similar tests he had conducted. He discussed the ways in which these results differed among listeners, who ranged from non–musically trained subjects to 'super experts' (famous musicians).

Ted Coons is a psychologist, neuro–scientist and multi–media catalyst for the arts. He currently teaches at New York University.

Concert/Workshop with the Mills Contemporary Music Ensemble. David Mahler, 8 November 1984.

This seminar represented David Mahler's conclusion to his week–long residence at Mills College during which he 'set pieces' on the Mills College Contemporary Music Ensemble. He gave a performance of and a lecture about some of his instrumental and text–sound music. The evening included a performance of his *Canons in Defense of the Sound* (for a large chamber ensemble) and *Maxfield's Reel*—an homage to the late composer Richard Maxfield, performed on solo violin by Heather Katz.

David Mahler is a composer of electronic and acoustic music. Many of his scores have been published by Soundings Press and in Michael Byron's anthologies, *Pieces* (1975, 1976).

New Music Software from Passport Systems. Phil Stone, 12 February 1985.

Phil Stone gave a presentation of a music program entitled MacMusic, which he had written for the Commodore 64 in his capacity as a programmer for Passport Systems. The program uses many of the user–interface features of the Xerox PARC/MacIntosh design—pull–down menus, scroll–bars, etc.—and gives the user complex control over the internal sound–production apparatus of the C-64 (known as the SID chip). The program also allows the user to specify long note-files, which describe the music parametrically, and to play them back or edit them. Finally, he demonstrated some experiments on the C-64 that attempted to present visual analogies to the sound produced.

A recent graduate of the Center for Contemporary Music at Mills College, Phil Stone is a composer, music software designer and programmer for Passport Systems. Some of his music software is in wide use for small systems, and he has been active in the design of experimental control and input structures for performance environments.

Whole Language Language. Kenneth Gaburo, 5 March 1985.

Kenneth Gaburo described his approach to composition and language and gave his views on the way language describes observation and vice versa. He made specific references to his own work as a composer, in which he had attempted to integrate formalized notions on the nature of communication with the communicative act itself. Much of his talk focused on a careful analysis of the ways a composer utilizes semantics and syntactics, and the ways these uses might be expanded, evolved and refined.

Kenneth Gaburo is a composer, author, linguist, systems theorist and innovator in interdisciplinary composition and performance. He has been a member of the music faculties of the University of Illinois, the University of California at San Diego and the University of Iowa, where he is currently director of the Electronic Music Studio. He is the founder of Lingua Press, a publisher of contemporary music and related materials. Gaburo was a Darius Milhaud Distinguished Visiting Professor of Music at Mills College in 1985.

A Personal Approach to Microcomputer Composition and Performance Systems and an Introduction to the Just Intonation Filter. Ron Kuivila, 12 March 1985.

Ron Kuivila presented and demonstrated his work using an Apple II computer with a Mountain Hardware sound–synthesis card and a variety of specialized input devices including ultrasonic motion and distance sensors. Kuivila talked about the basic pitch–generation design of the Mountain Hardware card and demonstrated how it was incapable of generating any pitches other than frequencies that are harmonics of a given fundamental. In this way, the card is inherently a just intonation device, and Kuivila showed some of his compositional algorithms which act as 'harmony pass filters'— binary sieves for pitch decisions which are essentially spectral configurations. Kuivila then demonstrated some of the ways he had used this idea in live performance and in installations.

Ron Kuivila, a graduate of the Center for Contemporary Music, is currently artist in residence at Wesleyan University in Middletown, Connecticut. He has studied with Alvin Lucier, Robert Ashley and David Behrman. His work integrates microcomputers, homemade electronics, live electronic music performance and installation art. With David Anderson he has recently developed a language called FORMULA, which affords the small

computer user with flexible and powerful music scheduling tools.

Trivial and Non–Trivial Machines. Heinz Von Foerster, 14 March 1985.

Heinz Von Foerster discussed basic automata theory in terms of trivial and non–trivial computation machines and related these concepts to the acts of observance and self–observance. He discussed the ways in which these abstract machines respond to various forms of finite and infinite sequences and generalized these notions to philosophical and systems theoretic observations on biological mechanisms and organizations.

Concert/Workshop with Larry Polansky. Ron Kuivila, 15 March 1985.

For the first half of his concert/workshop, Ron Kuivila concluded a week-long NEA sponsored residency working in the Center for Contemporary Music's computer music facilities. He talked about some of his recent work with small computer systems and ultrasonic motion–sensing input devices and played several of his pieces utilizing live computer electronics. The second half of the concert/workshop was devoted to a collaborative piece by him with Larry Polansky realized on the Center for Contemporary Music's (CCM) HMSL computer music system. The piece, *Buka Bucha*, incorporated some of the modifications made in HMSL during Kuivila's stay at the CCM (including scheduling algorithms and modifying analog input routines) and, to a greater or lesser degree, was based structurally on Javanese rebab improvisation patterns.

HMSL: Hierarchical Music Specification Language. Larry Polansky and David Rosenboom, 23 April 1985.

Polansky and Rosenboom discussed and demonstrated HMSL, a computer music language written on a 68000–based S–100 system in FORTH. Rosenboom discussed his piece *Zones of Influence*, for percussion and computer, which utilized many of the morphological transformation ideas of HMSL. Polansky's discussion detailed the data structures of the language and how they are used to create musical experiments. The demonstration continued in the CCM hybrid studio, where

the language was demonstrated on the computer itself.

The Design of Real–Time Hybrid Control Systems for Performer Interaction. Chris Brown, 1 May 1985.

Chris Brown described the computer and electronic designs of his set of pieces entitled *His Master's Voice*, for solo instrumentalists and a live interactive computer signal–processing system. Brown's system is comprised of a small computer controlling an array of analog signal–processing equipment, with control and audio voltages routed through a complex computer–controlled switching system. The pieces use careful time structures to control the ways in which the live performance is processed by the computer–controlled analog gear. He and Larry Polansky (electric bass) performed one of the pieces for the audience.

Chris Brown is a pianist, composer, experimental instrument builder and electronic systems designer who is a recent graduate of the Mills College Center for Contemporary Music. For the past few years, Brown has been designing a real–time interactive computer–controlled signal–processing system for use with live instrumentalists, both in improvisational and highly structured compositional contexts.

The Composers' Sketchbook: A Model for a Formal Language for Music Composition. David Rothenberg, 7 May 1985.

David Rothenberg described a model for a computer music language that would allow the composer sophisticated syntactical and grammatical control over scale formulation, pattern transformation, sectional organization and the like. In some ways, the language is 'object oriented', in that it allows the user to make specific definitions of musical entities early in the formulation of a piece and then to use linguistically based methods to pass parameters and to transform and invoke those 'objects'. Rothenberg's model, although a design proposal and not an implementation, is quite detailed in its formulation and seems to present a radical new approach to the use of computers in the specification of compositional constructs.

Sound–Driven Guitars and Low-Tech Computer Music. Nicolas Collins, 24 September 1985.

Nicolas Collins played examples of his recent work and discussed the techniques of their construction and the various implications of the materials used. Collins's music utilizes specially modified electronic devices—such as mixers, digital delays and electric guitars—often in radical new ways. The discussion ranged from descriptions of systems for computer–controlled mixers to debates on the significance of working with popular musical materials and commercial electronics.

Nicolas Collins is a composer and electronic instrument designer involved with the live performance of electronic music. Collins often works with 'found' sounds and objects, such as radio broadcasts or modified electric guitars, in performance situations in which he is able to control the sound modification properties of modified small processing systems.

Predictability and Surprise in European Music. Wilfred Mellers, 10 October 1985.

Wilfred Mellers traced the notions of dramatic manipulation through predictability and surprise in the history of Western art music, and he commented on the evolution of those ideas through the work of well–known European composers.

Wilfred Mellers is a contemporary musicologist. He is the author of the book *Music in a New Found Land* and has written on topics that range from music of the classic period to the Beatles and Bob Dylan.

The Structure of Pitch Perception. Roger Shepard, 14 November 1985.

Roger Shepard described several experiments that probed the perception of scale formations and intervallic combinations in relationship to cross–cultural experiential backgrounds of the listener. In one example, which involved a study that had taken place in a remote Balinese village, the subjects had not been exposed previously to Western musical scales. Shepard was reluctant to draw general conclusions about scale pattern recognition but raised important questions and described interesting methodologies.

Roger Shepard has long been a pioneer in this field of experimental psychology. His work with multi–dimensional scaling has had an impact on the study of perception; he has also contributed to the study of cognitive pitch structures. He is currently a professor of psychology at Stanford University.

Randomness. Gregory Chaitin, 27 February 1986.

Gregory Chaitin attempted to formulate a method for measuring the complexity of given musical systems using a metric from complexity theory that measures, in simple terms, the degree of similarity between two arbitrary sets. Chaitin formulated the distance measure in a number of ways and spoke at length about its intellectual history and its various applications. He then gave examples, mostly conjectural, of musical applications and related much of this to important aspects of the perception of contemporary music.

Gregory Chaitin is a mathematician and computer scientist who is known for his pioneering work in random–number theory and complexity. He has written on this topic as well as on many others, including the pedagogical uses of computers, and is the author of "Towards a Mathematical Definition of Life". For the past several years he has been involved in the design of RISC (Reduced Instruction Set Computers) for IBM Research.

Stalking the Wild Transducer. Richard Lerman, 4 March 1986.

Richard Lerman's seminar included a lecture, video tapes and a live electronic music performance. He described and demonstrated his use of transducers to pick up and amplify sounds that either were normally too difficult to mike any other way or were not typically thought of as sound producing. He also showed how transducers can be used to make objects other than speaker cones vibrate, often using these common objects as 'filters' for a pre–existent signal. He described in detail, with video documentation, his *Travelon Gamelan*, in which he amplifies the spokes of ordinary bicycles and then has local members of a community perform the piece by riding the bicycles around a city or town. Lerman also performed his piece *Plinkys and Straws*, in which small transducers are used to greatly amplify found objects such as plastic drinking straws. In this piece, Lerman demonstrated a home-made tape-delay system which he had built using two Sony Pro–Walkman cassette recorders.

Richard Lerman is a composer, installation artist, filmmaker and experimental instrument designer who specializes in the use of small transducers and everyday objects. He has performed his live electronic music worldwide and currently teaches audio art and filmmaking at the School of the Museum of Fine Arts in Boston, Massachusetts.

Automatic Music Transcription and Related Topics. Bernard Mont–Reynaud, 11 March 1986.

Bernard Mont–Reynaud discussed much of the research that is occurring at the Center for Computer Research in Music and Acoustics (CCRMA) at Stanford University in the field of automatic music transcription. He surveyed the techniques and experiments being used in a wide variety of areas including pattern recognition, fundamental extraction, rhythmic interpretation and polyphonic sources.

Bernard Mont–Reynaud is a computer music researcher and theorist currently at CCRMA at Stanford University. His recent work in pattern recognition and automatic music transcription has increased the capabilities of such systems and has helped to make the principles of these processes known to a larger community of researchers.

The Digital Piano Patch Control Language. Richard Teitelbaum, 20 March 1986.

Richard Teitelbaum described the Patch Control Language he developed for use with the Marantz Pianocorder and Vorzetzer unit. The language gives the composer/improviser a high degree of control over transformations of melodic and rhythmic sequences and over modes of the machines' response to the performer pianist. Teitelbaum next showed a video of a new piece he had performed recently in Germany using an ensemble of 20 Japanese Buddhist monks, all of whom were members of a sect that emphasized an ancient singing style. Teitelbaum, who had learned a great deal about the notation and performance of that style, had composed this piece for them.

Richard Teitelbaum is a composer and performer who has long been associated with live improvisational uses of electronic instruments as well as with the integration of world music in improvised and

composed contexts. He has performed with many innovative musicians, such as Anthony Braxton and George Lewis, and has extended the environment of live electronic performance by participating in the design of increasingly more intelligent and responsive instruments.

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GLOSSARY

ASP—a large–scale digital sound synthesis and editing system developed by LucasFilms.

CCRMA—Center for Computer Research in Music and Acoustics, Stanford University, Palo Alto, CA.

FORMULA—a music composition language, available for the Atari-ST computer, written by Ron Kuivila and David Anderson. It is written in FORTH and is intended as a language for complex musical event scheduling.

FORTH—a general purpose computer language designed and written by Charles Moore. FORTH is usually described as a "stack oriented, reverse Polish notation, threaded interpretive language". It is extremely popular among computer musicians who use microprocessor systems.

HMSL—(Hierarchical Music Specification Language) is an object–oriented computer music language designed and written at the Mills College Center for Contemporary Music by Phil Burk, Larry Polansky and David Rosenboom. It is a language which is intended for experiments in the generation and perception of musical form, and it incorporates real-time complex scheduling facilities. It is an extensible language in that the user actually writes programs in HMSL. It is currently available for three computers: a special purpose S-100 based 68000 system at the Center for Contemporary Music, the Commodore Amiga, and the Apple Macintosh.

MASC—a computer language for control of analog systems and MIDI devices, written by Daniel Kelley. MASC, written in FORTH, is one of the most portable computer music languages in existence and is available for a wide variety of computers.

MIDAS—a computer music language written in FORTH by Lynx Crowe of Buchla and Associates for the Buchla 400 digital synthesizer. MIDAS allows the user complex instrument definition, score editing and a wide range of timbral specification.

MIDI—(Musical Instrument Device Interface) is the music industry's standardized communication protocol and hardware specification for computers and electronic musical instruments.

PATCH-IV—a computer music language and system designed and built by Don Buchla and Associates in the late 1970s. PATCH-IV is one of the most sophisticated of all hybrid systems (computer control of analog gear) and uses a variety of special-purpose Buchla equipment, including a 'multiple arbitrary function generator', sometimes referred to as 'the MARF'. PATCH-IV allows the user powerful sequence generation capability, as well as a highly general definition of the computer music stimulus/response environment.

RISC—(Reduced Instruction Set Computer) is a philosophy of computer design in which the instruction set of the microprocessor is kept to a few, powerful instructions. Some of the proposed advantages to such machines are the large amounts of logic that can be incorporated into the chip, the ease and directness of programming them and the consistency of instruction speeds (usually, one clock cycle per instruction). Several RISC machines are now available commercially, including the IBM-PCRT.

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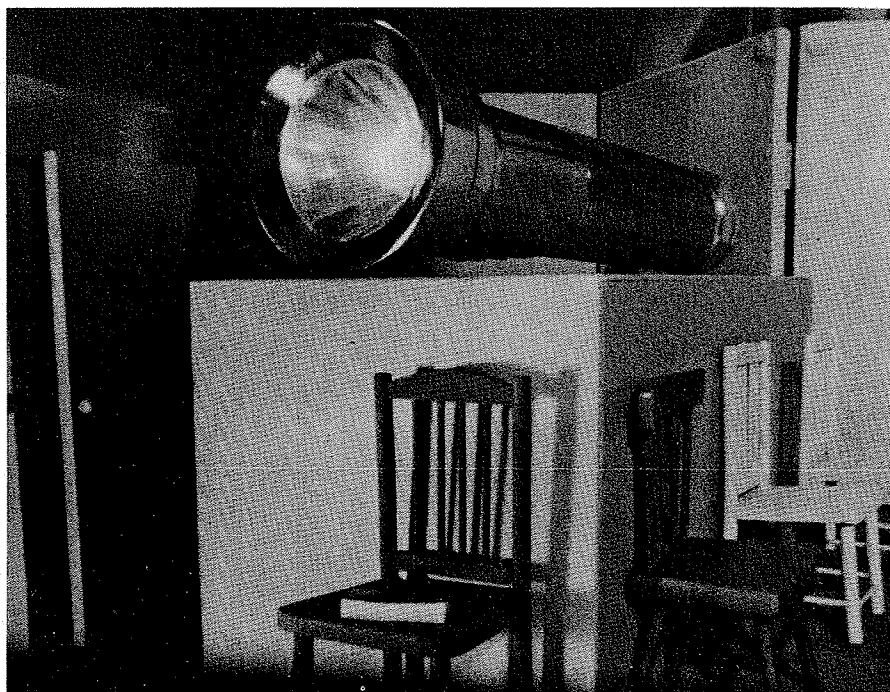
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