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- http://www.musicainformatica.org/topics/lejaren-hiller.php
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Lejaren A. Hiller, Jr.

A Memorial Tribute to a Chemist–Composer

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Of the various art forms, music seems to have a special connection and appeal to scientists and mathematicians. The parallels between chemistry and music have been cited by Harold Kohn (*1*)—in particular, the strict requirements of precision and rigor, which nevertheless leave open significant latitude for creativity and innovation. Indeed, the ability to be creative while maintaining (or expanding) the framework of the discipline is the most highly prized trait of practitioners of music or chemistry. Thus one might expect to find a few individuals who have successfully pursued dual careers in chemistry and music. However, there is just one commonly cited example.

Most chemists are aware that the Russian composer Alexander Borodin (1833–1887) was also an organic chemist. In fact, he was always a professional chemist first and a musician by avocation. Much has been written about Borodin as composer, and in recent years several articles (*2–5*) and a book (*6*) have appeared with emphasis on his chemical accomplishments. On the 100th anniversary of his death, Borodin was featured on the cover of *Chemical and Engineering News* (*3*). Less well-known is that the British composer Sir Edward Elgar enjoyed chemistry as a hobby (*7*).

We recently became aware of a modern American chemist/composer, Lejaren Arthur Hiller, Jr. (1924–1994) (Fig. 1). Like Borodin, Hiller was a professional chemist first who followed up on a strong personal interest in musical composition. His scientific and musical endeavors ran concurrently for a significant portion of his professional life, as illustrated in the chronology (Tables 1 and 2). However, unlike Borodin, Hiller ultimately found it impossible to pursue both professional careers simultaneously and made a distinct transition to music in midcareer. Hiller's musical career is well-documented (*8–15*), and those reports contain brief allusions to his chemical activities. The novelty of Hiller's musical career is that there are clear connections between his chemistry background and his approach to musical composition.

The Early Years with Music and Science

Lejaren Hiller was born in New York City on February 23, 1924. His father, Lejaren A. Hiller, Sr., was famous as an artist–photographer, generally acknowledged as the creator of American photographic illustration. As an example of the senior Hiller's approach to the merging of art and science, he was commissioned to illustrate a pictorial history of surgery, in which scenes of surgical procedures throughout history were recreated and photographed (*16*).

From the first through the 12th grades, young Hiller Jr. attended Friends Seminary, a Quaker-run private school, from which he graduated in 1941. During the period 1938–1941 he had piano lessons and also learned to play the clarinet and saxophone. In his early years he anticipated the duality of his later professional life by expressing interests in both chemistry and music. Even at an early age, his main musical interest was in composing rather than playing. His first attempts at creating music involved experimentation with the family player piano, for which he produced "satisfying effects by cutting designs and punching holes into the piano rolls" (*8*). In his high school years he sang in choral groups, played in a percussion ensemble, and composed a graduation march for his high school class. He earned his first money through music by singing the jingle for a pet food commercial for a radio station.

Hiller entered Princeton University in 1941 to study chemistry. According to Hiller, "I went to Princeton because I saw a college catalog one day and it sounded nice; my choice was as random as that" (*9*). Nevertheless it was an opportune choice, since he aligned himself with superb progressive programs in both music and chemistry. He continued his musical education in theory and composition under the composers Milton Babbitt and Roger Sessions. He also took lessons in the oboe and took part in many of the regular concerts presented at Princeton. In addition, he played with and managed a college dance band for many years. When Sessions left Princeton for Berkeley in 1945, he urged Hiller to join him, and also offered to arrange for Hiller to study with Arnold

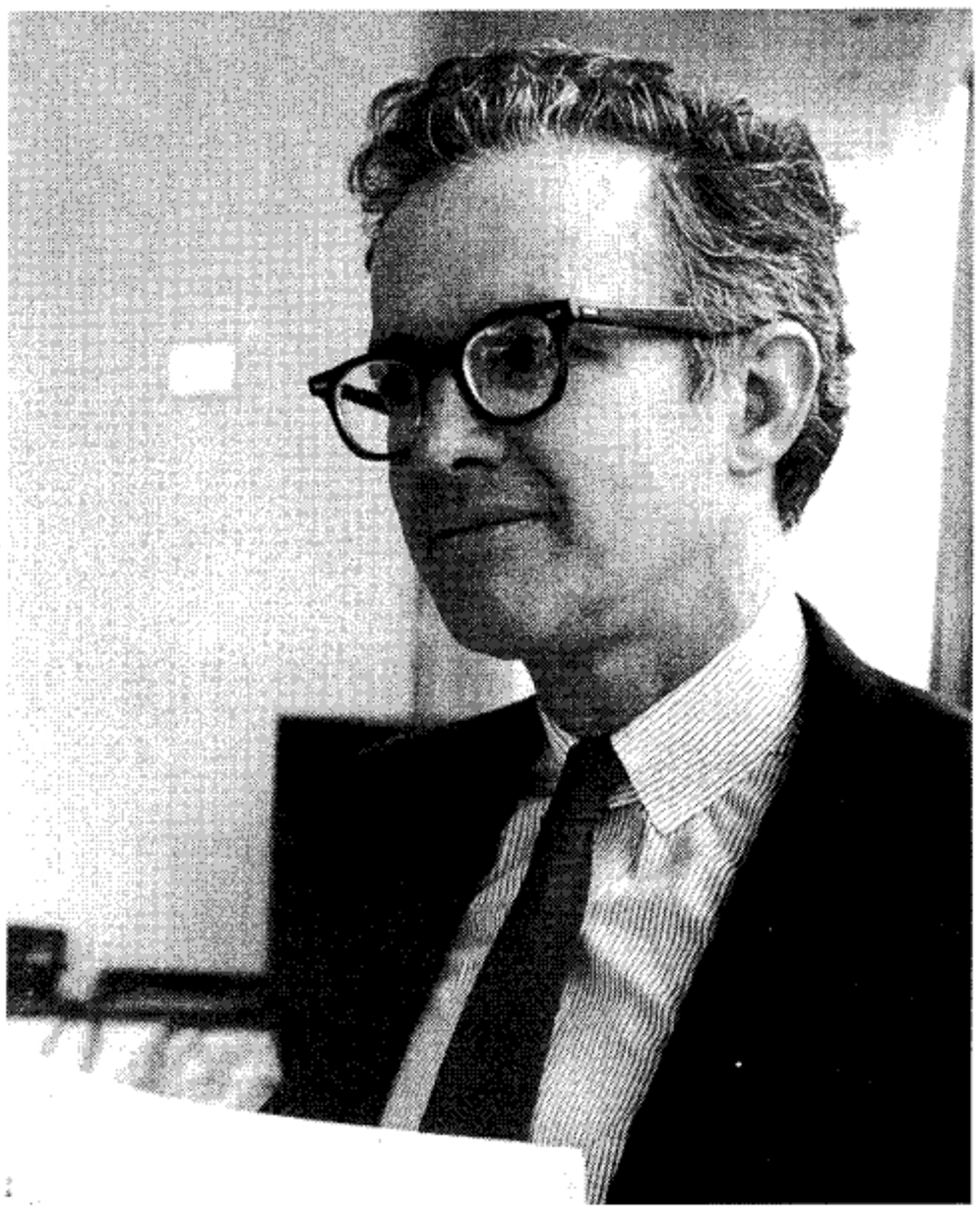

Figure 1. Lejaren A. Hiller, Jr. (1924–1994)

Table 1. A Chronology of Major Professional Events in the Life of Lejaren A. Hiller, Jr., 1941–1962

Year	Hiller as Chemist	Hiller as Composer
1941	Chemistry student at Princeton	Music student at Princeton
1944	BA in Chemistry, Princeton	
1946	MA in Chemistry, Princeton Published four papers on cellulose	*Piano Sonata No. 1* (revised in 1968)
1947	PhD in Chemistry, Princeton Joined DuPont as a research chemist	*Pianoforte Trio* (violin, cello, piano) *Piano Sonata No. 2*
1948		*Seven Artifacts* (for piano, rev. 1973)
1949		*String Quartet No. 1* *Piano Concerto* *Violin Sonata No. 1* *Children's Suite* (for piano)
1950		*Piano Sonatas Nos. 3 and 4* *Jesse James* (for vocal quartet and piano)
1951		*String Quartet No. 2* *Suite for Small Orchestra* *Fantasy for Three Pianos*
1952	Joined the Chemistry Department at the University of Illinois, Urbana, as a postdoctoral research associate	
1953	Paper on cellulose acetate (DuPont) Patent on activation of cellulose (DuPont) Assistant Professor of Chemistry, University of Illinois	*Symphony No. 1* *String Quartet No. 3* Continued music studies at the University of Illinois
1954	Paper on reaction of cellulose acetate with acetic acid (DuPont) Paper on statistical calculations of macromolecular dimensions (U. Illinois)	*Twelve-tone Variations for Piano*
1955	Two papers on statistical calculation of macromolecular dimensions (U. Illinois)	Hiller and Isaacson begin to use the Illiac computer as a music composition aid *Violin Sonata No. 2* (also arranged as a cello sonata)
1956	Patent on esterification of cellulose (DuPont) Patent on wool-polyacrylonitrile dyeing (DuPont)	*Two Theater Pieces* (for piano)
1957	Paper on molecular dimensions of polymers (U. Illinois)	*String Quartet No. 4, "Illiac Suite"* (with Leonard M. Isaacson) Incidental music for *A Dream Play*
1958	Paper on computation of reaction probabilities (U. Illinois)	Master of Music Degree (University of Illinois) Assistant Professor of Music and Founding Director, Experimental Music Studio, University of Illinois Incidental music for Aristophanes' *The Birds* *Scherzo for Piano* *Five Appalachian Ballads* (for voice with guitar or harpsichord)
1959		*Divertimento* (for eleven instruments, including theremin) *Experimental Music: Composition with an Electronic Computer* (book with Leonard M. Isaacson) Incidental music for *Blue Is the Antecedent of It*
1960	*Principles of Chemistry* (textbook with Rolfe H. Herber)	*Symphony No. 2* *Cuthbert Bound* (for four actors and tape) Designed computer compositional programming language, MUSICOMP (with Robert A. Baker)
1961	Paper on computation of reaction probabilities (U. Illinois)	Associate Professor of Music (University of Illinois) *Piano Sonata No. 5* *Nightmare Music* (for tape) Suite from *Time of the Heathen* (for chamber orchestra)
1962	Paper on automatically controlled isothermal adiabatic calorimeter (U. Illinois)	*String Quartet No. 5, "In Quarter Tones"* Incidental music for *Man with the Oboe* Amplification (overture for theater band and tape) *Spoon River, Illinois* (for two narrators and six instruments)

Schönberg. However, Hiller was involved with the establishment of a new Textile Research Institute and chose to continue in the chemistry graduate program at Princeton. In 1945, he married Elizabeth Halsey, with whom he eventually adopted two children. His first formal composition, a piano sonata, was written in 1946 and later revised in 1968.

The Early Chemistry Career—Cellulose Chemistry

Hiller's chemical work at Princeton was an extension of prior studies there in the field of cellulose chemistry and led to a series of publications in the *Textile Research Journal* (*17–20*). These investigations dealt with such aspects of cellulose chemistry as methods for determining functional groups (e.g., reducing end-groups and carboxyl groups), the nature of "hydrocellulose", and the hydrolytic degradation of cellulose in phosphoric acid solutions. Hiller earned three degrees in chemistry from Princeton: BA (1944), MA (1946), and PhD (1947). The doctoral dissertation was entitled *The Chemical Structure of Cellulose and Starch*.

After leaving Princeton in 1947, he spent four years as a research chemist at DuPont in Waynesboro, Virginia. During this period he continued to write music: for example, several works for piano, two string quartets, and a violin sonata. A piano concerto (1949) and a suite for small orchestra (1951) were the first compositions to be performed publicly, at a concert of the Virginia Symphony Orchestra in Waynesboro on April 17, 1951. His compositions to this time are generally considered as transitional works between his musically conservative past and his innovative future.

Hiller's work at DuPont continued in the field of cellulose chemistry with emphasis on esterification, and led to publications which appeared later in the *Journal of Polymer Science* (*21, 22*). These dealt with the reactions of cellulose and cellulose acetate with acetic acid and led to postulated reaction mechanisms based on kinetic and functional group concentration data. His work at DuPont also generated several patents that were issued later (*23–25*). Two of the patents described processes for the activation of cellulose as a pretreatment for esterification based on thermal or acid treatment; the other patent described a process for selectively dyeing a fibrous wool–polyacrylonitrile blend (e.g., Orlon). Hiller regarded the latter as an important basic contribution.

The Transition—Computers for Chemistry and Music

Hiller gave up his career in industrial chemistry in 1952 and left DuPont to become a research associate with Frederick T. Wall in the Chemistry Department of the University of Illinois at Urbana. Fred Wall had been a consultant for DuPont and encouraged Hiller to follow up on his interests in an academic career. At Illinois, Hiller had access to the University's room-sized ILLIAC I (an acronym for Illinois Advanced Computer). He used the ILLIAC to carry out statistical computations of polymer molecule dimensions and reaction probabilities. Specifically, the Monte Carlo method was used to generate a statistical sampling of polymer conformations using a simple random walk approach. According to Wall (*26*), the collaborative work with Hiller and D. J. Wheeler (*27*) (a visiting mathematician from Cambridge, England) on the polymer configuration problem employing the Monte Carlo method was a first of its kind and possibly the best scientific paper that Hiller was involved in at the University of Illinois. Theoretical calculations of the mean dimensions of flexible macromolecules had been the subject of numerous publications up to that time, but the "excluded volume" effect had never before been specifically taken into account. The availability of a high-speed digital computer allowed a purely numerical procedure to provide statistically significant data to resolve this problem.

In the mid-1950s Hiller began to explore the computer's musical possibilities, in collaboration with Leonard Isaacson, a graduate student in the Wall research group, whom Hiller acknowledged as a "super" programmer. Their approach clearly shows the juxtaposition of scientific and artistic methods (*28*):

> . . .when we raise this question of whether it is possible to compose music with a computer, we may note the following points: (1) Music is a sensible form. It is governed by laws of organization which permit fairly exact codification. (As we shall later note, it has even been claimed that the content of music is nothing but its organization.) From this proposition, it follows that computer-produced music which is "meaningful" is conceivable to the extent to which the laws of musical organization are codifiable. (2) It is a feature of digital computers that they can be efficiently used to "create a random universe" and to select ordered sets of information from this random universe in accordance with imposed rules, musical or otherwise. (3) Since the process of creative composition can be similarly viewed as an imposition of order upon an infinite variety of possibilities, an analogy between the two processes seems to hold, and the opportunity is afforded for a fairly close approximation of the composing process utilizing a high-speed electronic digital computer. In this context, it should be noted that the composer is traditionally thought of as guided in his choices not only by certain technical rules but also by his "aural sensibility," while the computer would be dependent entirely upon a rationalization and codification of this "aural sensibility".

Essentially, Hiller and Isaacson proposed that the composition of music could be treated by the recently popularized Monte Carlo method (*29*), which each of them had used in their chemistry research. In testing their hypothesis, they composed the first computer-generated musical score, which they entitled the *Illiac Suite for String Quartet* (1957). The four movements (labeled "Experiments") address increasingly complex musical forms, from first-species strict counterpoint in Experiment 1 to "a complete departure from traditional compositional practice" (*28*) in Experiment 4. The computer output was transcribed as notes on traditional musical staves to be performed by a string quartet. Even before the third experiment was completed, the first public performance took place on August 9, 1956, at a concert at the University of Illinois. The event attracted considerable attention and made Hiller famous as the first composer to write music with a computer. Although the attention was widespread and even reached the front page of some newspapers, not everyone appreciated this work. According to Hiller, "some people had already become livid with rage over it" (*9*). Since then the *Illiac Suite* has had many performances and has been recorded, and it has taken its place as a milestone in the evolution of musical composition.

By 1958, Hiller had earned a master's degree in music at the University of Illinois and recognized that music composition had become an increasingly compelling interest for him. He had become increasingly frustrated by the observation that musical professionals ignored his work simply because he was not recognized as a musician. With the support of his former mentor and then Dean of the Graduate School, Fred Wall, Hiller was formally

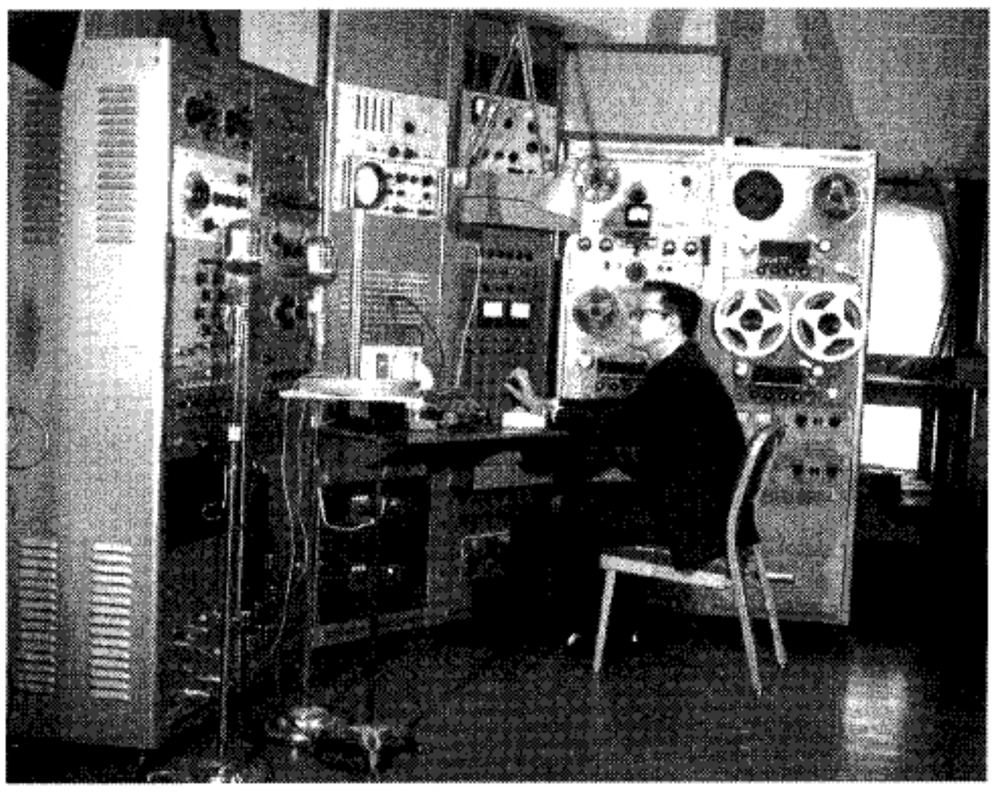

Figure 2. Lejaren Hiller in the Experimental Music Studio at the University of Illinois.

included in the Music Department at the University of Illinois in 1958, specifically to establish an Experimental Music Studio. The transfer was accomplished over the quiet summer months, because as Fred Wall diplomatically recalled, "there was some division of opinion on his music" (*26*). Hiller started by teaching musical acoustics, and used this as a way to introduce electronic music into the curriculum (Fig. 2). During his 10 years at the Experimental Music Studio, he developed a collaborative research program with the electrical engineering department involving electronics, computers, acoustics, and music. Hiller recognized that his courses at Princeton in electronics and electrical engineering served him well here. He continued to compose music in both conventional and computer-generated forms.

In 1959, Hiller and Isaacson published *Experimental Music: Composition with an Electronic Computer* (*28*). The book has been described as a "technical landmark for those who can read it" (*30*). It summarizes the experiments that went into the composition of the *Illiac Suite*, with the book organized remarkably like a scientific paper (*28*):

> A reasonable organization of the material seemed to be the following: (1) To introduce aesthetic limits to the problem, that is, to define what can be accomplished musically with a computer at the present time, and to define what is—at the moment at least—outside the scope of available experimental tools. . . . (2) To define the area of research musically, that is, to distinguish these experiments from and to correlate them with other types of musical experiments both of the past and now in progress. . . . (3) To consider . . . technical problems. In this discussion, we are basically concerned with two subjects; the first being a description of how modern computers operate, and the second being a general discussion of the mathematical methods used to set up the problem of generating computer music. (4) The next two chapters of the book contain detailed descriptions of the experimental techniques and the experimental results. In Chapter 5, the programming techniques for the various musical problems studied are reviewed in considerable detail, while in Chapter 6, a description and an evaluation of the contents of the Illiac Suite are given. (5) Finally, in Chapter 7, we suggest a number of possible extensions of this work in the fields of music analysis and music composition.

Despite the musical activity, Hiller's interest in chemistry continued, and he collaborated with Rolfe H. Herber on a chemistry textbook *Principles of Chemistry* (*31*), published in 1960. The text was reviewed in *this Journal* in 1960 by James L. Hall, and it received warm praise for its innovative approach and excellent writing (*32*). (The price of the book was listed at $7.75.) During this time, Hiller's continued work in the Wall research group at the University of Illinois led to five further publications in the *Journal of Chemical Physics* (*33–37*) that dealt with computer-aided statistical computations of polymer dimensions and reaction probabilities. Hiller's final chemical publication in 1962 described an automatically controlled isothermal-adiabatic calorimeter (*38*).

The Music Career—Computer Composition

Hiller's second symphony, written without computer assistance, was published in 1960. Hiller also began a collaboration with Robert A. Baker, a graduate student in music, in designing a compositional language for computer generation of music, called MUSICOMP (MUsic SImulator-interpreter for COMpositional Procedures) (39). One of their first compositions was *Computer Cantata* for soprano, tape, and chamber ensemble (1963). This was the first piece to use computer-generated sounds in association with more traditional electronic and natural sound sources including the voice. The specified pitches, durations, amplitudes, and timbres were all determined by random-probability programs based on an excerpt from Charles Ives' *Three Places in New England* (*40*).

In describing his novel stochastic approach to generation of musical selections, Hiller finds himself referring to chemical concepts (*41*):

> I propose that we can also define other classes of musical communication systems in which a particular composition is but one example from a large class of essentially similar compositions. If certain elements are changed within the matrix of elements making up a system of this sort, a different composition in terms of fine detail may be produced, but its gross properties taken as a whole remain essentially the same, and its effect upon the listener also remains essentially the same. In a way, we have here a crude analogy to the kinetic theory of gases, if one wishes for a moment to think about physics. According to this theory, we can predict rather accurately the macroscopic properties of a body of gas, but we cannot determine the particular positions or energy contents of individual molecules within the total body of this same gas.
>
> This mention of the kinetic theory of gases brings me to the concept of information as embodied in the mathematical theory of communication . . . that information is defined as a quantitative measure such that high information content is associated with a relatively high degree of disorder, unpredictability, or even randomness, and that order is measured by the opposing conjugate property of redundancy. Let me immediately emphasize, however, that when we say that a system has high information, high entropy, high disorder, and lack of predictability, we are simply making a statement concerning how much information is present, and we are not committing ourselves in any way as to whether this information is to be considered "good" or "bad" in the normal sense. . . . I am occasionally asked, "How can you get a computer to write a piece of good music?" I reply that if I can be told what "good music" is in terms of precise and quantitative algebraic statements, I can produce "good music".

Beginning in 1967, Hiller collaborated with the noted composer John Cage on one of their most famous creations, HPSCHD (an acronym for harpsichord, the sole performance instrument, along with computers). Both Hiller and Cage were intrigued by the element of chance and ran-

Table 2. A Chronology of Major Professional Events in the Life of Lejaren A. Hiller, Jr., 1963–1989

Year	Hiller as Composer
1963	*Seven Electronic Studies* (with Robert Baker) *Computer Cantata* (for soprano, tape, and chamber ensemble) (with Robert Baker)
1964	*Machine Music* (for piano, tape, and percussion) *Informationstheorie und Computermusik* (book)
1965	Professor of Music (U. Illinois)
1966	*Suite for Two Pianos and Tape* *A Triptych for Hieronymus* (for actors, dancers, orchestra, tape, slides, and film)
1968	Professor of Composition in the Department of Music, State University of New York at Buffalo Co-director (with Lukas Foss) of the Center for Creative and Performing Arts in Buffalo *Algorithms I* (for nine instruments and tape) *An Avalanche for Pitchman, Prima Donna, Player Piano, Percussionist, and Prerecorded Playback* *Computer Music for Percussion and Tape* (with G. Allan O'Connor) *HPSCHD* (for 1–7 harpsichords and 1–51 computer-generated tapes) (with John Cage)
1969	*Three Rituals* (for percussion, film, and light)
1970	*Sonata No. 3* for Violin and Piano
1971	*A Cenotaph* (for two pianos)
1972	Piano Sonata No. 6 *"Rage over Lost Beethoven"* *Algorithms II* (for nine instruments and tape) (with Ravi Kumra) *String Quartet No. 6*
1973	Fulbright lecturer on music (Warsaw)
1974	*Six Easy Pieces* (for violin and piano) *A Portfolio for Diverse Performers and Tapes*
1975	*Malta* (for tuba and tape) *A Preview of Coming Attractions* (for orchestra)
1976	*Electronic Sonata* (for four-channel tape) *Midnight Carnival for an Urban Environment* (for principal and subsidiary tapes and indeterminate number of other events)
1977	*Persiflage* (for flute, oboe, and percussion) *Ponteach* (melodrama for narrator and piano)
1978	*Diabelskie Skrzypce* (for "devil's fiddle" and harpsichord)
1979	*An Apotheosis of Archaeopteryx* (for piccolo and berimbau) *String Quartet No. 7*
1980	*Minuet and Trio* (for six players) Fulbright lecturer on music (Bahia, Brazil) *Two Dances for Zygmunt Krause* (clarinet, trombone, cello and piano)
1981	*Quadrilateral* (for piano and tape)
1982	Incidental music for Chang Fu *The Witch of Moon Mountain*
1983	Three compositions for tape *Tetrahedron* (for harpsichord)
1984	*Staircase Tango* *Fast and Slow* (saxophone quartet) *Algorithms III* (for nine instruments and tape)
1985	*Expo '85* (for multiple synthesizers) *The Fox Trots Again* (for chamber ensemble)
1986	*Metaphors for Four Guitars*
1989	*John Italus* (for narrator and instruments) *Symphony No. 3* (only two movements completed)[a]

[a]Although Hiller's *Symphony No. 3* remained unfinished at his death, an effort to complete it is underway by Andrew Stiller of Kallisti Music Press in Philadelphia. Stiller was a student of Hiller's at SUNY Buffalo. Among his compositions is a piece for chamber orchestra with the provocative (to chemists) title: *A Periodic Table of the Elements* (1988).

domness, and they used the elements of the Chinese *I Ching Book of Changes* as well as Mozart's *Musical Dicegame* (K. 294d) to generate programs to create random selections for successive sections. The inputs for the computer programs were piano pieces by Mozart, Beethoven, Chopin, Schumann, Gottschalk, Busoni, Schönberg, Cage, and Hiller. In performance, seven harpsichordists played together with 51 computer-generated tapes. HPSCHD had its premier performance on May 16, 1969, in a circular 18,000-seat auditorium at the University of Illinois. The musical performance was accompanied by exterior and interior lighting, slides, and films, creating an immense complex of sight and sound designed to achieve an effect of calculated chaos. An eyewitness (and earwitness) account of the event is provided by Richard Kostelanetz (*10*), who also characterized it in the *New York Times* as "the multimedia event of the decade" (*8*). The piece has been performed many times since then, and can be accommodated by anywhere from one to seven harpsichords and one to 51 tapes. In preparing for the premier performance, John Cage played the solo parts, which were combined with the prerecorded computer tapes and assembled into a recording that was completed even before the initial performance. The recording was packaged with a printout called KNOBS, which was a unique iteration, of 10,000 total possibilities, of a program that allowed the home listener to get involved in the performance by adjusting stereo settings during the playback.

In 1968, Hiller moved from the University of Illinois to become the Frederick B. Slee Chair of Composition in the School of Music at the State University of New York at Buffalo, where he spent the remainder of his professional career. From 1968 to 1974 he was also co-director (with Lukas Foss) of the Center for the Creative and Performing Arts, which helped to establish Buffalo as a major center for avant-garde music at that time.

Although much of Hiller's work was didactic, meant to illustrate particular compositional techniques, he also composed a significant number of theatrical pieces. He ascribed his penchant for theater pieces to the influence of his wife, an actress. One such piece, *Avalanche*, was written for pitchman, prima donna, player piano, percussion, and tape and was considered to be a typical sampling of his satirical wit, parodying everything from culture centers and prima donnas to academic philosophers (*42*).

Midnight Carnival, another theatrical work created on a scale even grander than HPSCHD, was commissioned for an outdoor performance in St. Louis on the eve of July 4, 1976, as a bicentennial celebration. For this occasion, the downtown area of St. Louis was set up as an electronic environment with many loudspeakers scattered over a dozen or more city blocks, and about 20–30 thousand people attending. The work was scored for 43 channels of tape and originally ran for over four hours, but a condensed 53-min version for indoor performance was created from the so-called "core tape" and designated *Electronic Sonata* (*43*).

Hiller served as a Fulbright lecturer in music in Warsaw (1973–1974) and in Salvador da Bahia, Brazil (1980). From his travel experiences, he de-

Table 3. A Discography—Recordings of Works by Lejaren A. Hiller, Jr.

Recording	Contents
Spectrum SR-190	*Seven Artifacts* (excerpts) (1948/1972), *Children's Suite* (excerpts) (1949), *Fantasy for Three Pianos* (1951), *Two Theater Pieces* (1956), *Diabelskie Skrzypce* (1978), *Quadrilateral* (1981)
Orion ORS 78287	*Jesse James* (1950), *Appalachian Ballads* (1958)
Turnabout 34536	*Twelve-Tone Variations* (1954), *Machine Music* (1964), *Violin Sonata No. 3* (1970)
Heliodor HS-25053	*Illiac Suite* (1957), *Computer Cantata* (1963)
Orion ORS 75156	*Piano Sonatas Nos. 4 and 5* (1961)
Vox SVBX 5306	*String Quartet No. 5* (1962)
CRI 310	*Computer Cantata* (1963)
Heliodor HS-25047	*Machine Music* (1964)
Heliodor 2549006	*Computer Music for Percussion and Tape* (1968), *Avalanche* (1968)
Deutsche Grammophon 2543005	*Algorithms I*, versions I and IV (1968)
Nonesuch H-71224[a]	*HPSCHD* (1968)
CRI 332	*String Quartet No. 6* (1972)
CRI 438	*Portfolio* (1974)
Spectrum SR-131	*An Apotheosis of Archaeopteryx* (1979)
Wergo CD 60128	*Illiac Suite (String Quartet No. 4)* (1957), *Avalanche* (1968), *Computer Music* (1969), *Persiflage* (1977), *Expo '85* (1985)
New World CD 384-2	*Metaphors for Four Guitars* (1986)

[a] Each copy of this recording was provided with the printout of a unique iteration of a program called "KNOBS" that generated instructions for manipulating the volume and tone controls of the listener's home stereo system.

veloped novel musical pieces: for example, *Diabelskie Skrzypce* was composed for a "devil's fiddle," a three-stringed instrument that he found in a souvenir shop in Poland, and *An Apotheosis of Archaeopteryx* is written for a berimbau, a Brazilian percussion instrument made of bamboo, coconut shell, and a single iron wire. In 1980 Lejaren Hiller was named the Birge–Cary Professor of Music at SUNY Buffalo, and in 1990 he retired.

In 1970, Hiller published a comprehensive review of the history of computer music (*44*) and in 1981 he prepared an updated progress report for *Computer Music Journal*, which was later reprinted (*45*). Taken together with his book *Experimental Music* (1959) (*28*), these works provide detailed insights into the evolution of his compositional procedures, including analyses of the mathematical and logical structures involved.

In a 1980 interview (*9*), Hiller reflected on his computer music and felt that it possessed more expressive content than he would have guessed, even considering some subjective biases that entered into the programming. He also acknowledged the ongoing difficulties of convincing people that his efforts represented a legitimate method of musical composition. Nevertheless, the difficulties caused him little concern (*9*):

> I write what I want to write and in the final analysis have never been much concerned whether other people (other composers, critics, audiences, anyone) approve or disapprove. It is not that I am arrogant, hostile, or embattled. Not at all! It's just that I get wrapped up in each successive compositional (or research) project and its necessities seem (to me) to override other considerations.

Lejaren Hiller died in Buffalo on January 26, 1994, having suffered from Alzheimer's disease for the previous seven years. He is survived by his wife Elizabeth, son David, and daughter Amanda.

The musical archives of Lejaren Hiller are held at the Music Library at the State University of New York at Buffalo. A list of his recorded works is given in Table 3. A retrospective recording of some of Hiller's representative works has been released recently (Wergo CD 60128) and was reviewed very favorably (*46*). The musical archives of Lejaren Hiller are held at the Music Library at the State University of New York at Buffalo. In addition, the Experimental Music Studio at the University of Illinois remains an active site for contemporary music and maintains significant information resources about Hiller and the Illiac (*47*). The Fall 1996 ACS Meeting (Orlando, Florida) will include a symposium on Lejaren Hiller (*48*).

A Personal Note from the Authors—Chemists and Music

It is interesting to speculate on the possibility that there may be or have been other dual-career chemist/composers. We would be pleased to hear of any other examples. More likely, as suggested by Harold Kohn (*1*), is that there are many professional chemists who are also competent nonprofessional musicians. Thus Kohn cites as examples violist Martin Kamen, the codiscoverer of ^{14}C, and cellist Waldo Cohn, originator of the ion-exchange method for separating nucleic acids. Cohn was also ringleader of a group of chamber musicians who attended FASEB meetings and played string quartets after dark with the same fervor that characterized their scientific debates during the day. Among Nobel Prize winners, Manfred Eigen, is a concert pianist and Christian Anfinsen is a violist. There are probably many more such chemist/musicians.

The most all-encompassing projection is that there must be innumerable chemists who also love music. The two authors are certainly included, and we are especially pleased that our love of both chemistry and music has brought father and son to their first collaborative publication.

Acknowledgments

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