

# A Chronology / History of Electronic and Computer Music and Related Events 1900 - 2014 (without frames)

Last updated 5 January 2013

This page is currently being maintained.  
Please send suggestions and corrections to  
paul.doornbusch at gmail dot com  
a subject of 'Chronology' gets my attention.

© Copyright 2008-2014\* Paul Doornbusch.

This is a somewhat extended and updated version based on the same item originally published in [The Oxford Handbook of Computer Music](#) late in 2009. When attempting such a chronology or timeline, even one such as this which mostly ignores the commercial music world, it quickly becomes apparent that there is *so* much activity that it will necessarily be incomplete. It is impossible to list *all* of the events which have taken place in any locale or time. Given these limitations, perhaps this is still of some limited use as some sort of chronological overview of computer music research and related events, and I welcome suggestions for updates.

This concentrates on electronic and computer music and includes fewer details of commercial music than a more comprehensive chronology might. Please see the [references](#) for a more detailed treatment of events ([note 1](#)).

Year	Selected Significant Musical Events	Main Technological Events	Electronic / Computer Music Events
< 1900		<p>Cylinder and disk recordings are common, as is the telephone.</p> <p>Moving pictures exist, but not with sound.</p>	
1906	<p>First public performances of Thaddeus Cahill's Dynamophone, also known as the Telharmonium (developed in 1897).</p>	<p>J. L. Baird creates the first working (electromechanical) television.</p> <p>Frank Conrad makes the first radio broadcast of audio.</p> <p>Lee De Forest develops the Triode (thermionic valve) or Audion tube, the first vacuum tube, which brought with it electronic amplification.</p> <p>Sigmund Freud's theories of the unconscious and psychoanalysis gain recognition.</p> <p>Albert Einstein publishes the Special Theory of Relativity.</p> <p>Magnetic wire recorders, invented in the 1890s by</p>	

		<p>Valdemar Poulsen, are common but not of high sound quality.</p> <p>The first optical film sound systems emerge.</p> <p>Max Planck's quantum theory gains acceptance (published in 1900).</p> <p>Victor Talking Machine Company releases the (popular) Victrola gramophone and Enrico Caruso is recorded.</p>	
1907		Bakelite is invented.	Ferruccio Busoni publishes <i>Sketch of a New Aesthetic of Music</i> , influencing his students Percy Grainger, Luigi Russolo and Edgard Varèse.
1909		<p>Disk records, invented and produced by Emile Berliner become the more popular format than Edison's cylinder records.</p> <p>AT&amp;T announces a national telephone system plan.</p>	Futurism movement founded by Filippo Tommaso Marinetti.
1911		George O. Squire patents "Wired Wireless", transmitting music over wires or cable, his company achieved success from the early 1920s transmitting music into business (and elevators) and changed its name to <i>Muzak</i> in the 1930s.	
1912		Titanic sinks, and through Morse code becomes the first real-time global news event.	
1913		<p>Ford assembly line produces the Model T.</p> <p>Kinetophone is introduced, to attempt synchronisation of film with a cylinder record.</p>	<i>The Art of Noises</i> (futurist manifesto) by Luigi Russolo is published.

1914	Luigi Russolo and Filippo Tommaso Marinetti give the first concert of Futurist music, complete with 'intonarumori' (acoustic noise generators) in Milan.	Panama Canal opens.  World War I starts (ends in 1918).	
1917		Edwin Armstrong and Lee De Forest separately invent an electronic oscillator with the Audio tube.	Lev Termen (Léon Theremin) starts developing the Aetherophone (later Theremin), the first electronic instrument with a unique performance technique.
1920	Stephan Wolpe uses eight gramophones at different speeds in a Dada performance.	Albert Einstein becomes famous for correctly predicting the bending of light by the sun in his General Theory of Relativity of 1916.	
1922			Darius Milhaud experiments with record manipulation to create music.
1924	Ottorino Respighi composes <i>Pini di Roma</i> (for large orchestra and gramophone).  George Antheil composes Ballet Mécanique (premiered 1926) in Paris, with the filmmaker and artist Fernand Léger (for player pianos, airplane propellers, percussion and electric bells - with the mechanised instruments providing the "ballet").	Rice and Kellog, of General Electric, develop the modern "dynamic" or "moving-coil" loudspeaker, although mechanical and other electrical speaker systems existed earlier.	Lev Termen (Léon Theremin) completes the Aetherophone (later named the Theremin).
1928	Fritz Walter Bischoff composes <i>Hallo! Hier Welle Erdball!</i> (optical film playback) using optical recording facilities.	First recordings made specifically for radio broadcast.  Magnetic tape recorder developed by Fritz Pfeumer in Germany, it used iron oxide on paper tape.  First Neuman microphone, the CMV3 "bottle" condenser microphone.  Harry Nyquist develops analog signal sampling theory.	René Bertrand develops the Dynaphone, a dial operated vacuum tube oscillator instrument.  Paul Hindemith and Ernst Toch experiment with electronically generated sounds at the Hochschule für Musik in Berlin which took an early decision to facilitate a research program in the manipulation of phonograph records.

		<p>Quantum physics replaces Newtonian physics at the atomic scale.</p> <p>Synchronized sound (often from disks) with films is now common.</p>	<p>Maurice Martenot builds the Ondes Martenot (first called the Ondes Musicales).</p>
1929	<p>Paul Hindemith and Ernst Toch compose three recorded studies titled <i>Grammophonmusik</i>, but they have been lost.</p> <p>Arseny Mikhaylovich Avraamov and Yevgeny Sholpo draw directly onto optical film using an ink pen to synthesize sounds.</p>	<p>British Broadcasting Corporation (BBC) starts broadcasting.</p> <p>Edwin Hubble discovers galaxies and red shift, confirming expanding-universe theory.</p> <p>The phonograph (cylinder) division of the Thomas Edison company closes and Victor Talking Machine Company is purchased by the Radio Corporation of America (RCA).</p> <p>The stock market crashes, causing the great depression.</p>	
1930	<p>G. V. Alexandroff composes <i>A Sentimental Romance</i> (optical film playback) using optical recording facilities.</p> <p>Walter Ruttmann composes <i>Weekend</i> (optical film playback) using optical recording facilities.</p>		<p>Friedrich Trautwein completes the Trautonium.</p>
1931	<p>Jack Ellit composes <i>Journey #1</i> (for optical film playback) using optical recording facilities.</p> <p>Rouben Mamoulian's film <i>Jeckyll and Hyde</i> uses electroacoustic montage moments in the soundtrack.</p> <p>Edgard Varèse composes <i>Ionisation</i> (for percussion).</p> <p>Dziga Vertov composes <i>Enthusiasm</i> (optical film playback) using optical recording facilities.</p>	<p>Alan Blumlein receives a patent for 'stereo' sound recording and reproduction.</p> <p>Columbia introduce the first 'long playing' record, a 12 inch disk with a rotation of 33 1/3 RPM.</p> <p>Empire State building opens.</p> <p>First radio telescope built by Bell Labs.</p>	<p>Léon Theremin completes the Rhythmicon for Henry Cowell who commissioned it - a machine to play musical rhythms with the same relationships as the overtone series.</p>

1932	Clara Rockmore performs on the Theremin in concerts worldwide.	<p>Bell Labs records in stereo using a special disk cutter built with two, stacked, turntables and disks keyed with another hole near the centre to maintain synchronization.</p> <p>First magnetic tape recorders developed by Allgemeine Elektrizitäts Gesellschaft (AEG) in Germany, called the Magnetophon, but performance was poorer than the wire recorders of the day.</p>	<p>Yevgeny Alexandrovitch Sholpo develops the Variophone, using sound waves drawn onto transparent 35mm film to control the generation of sounds via photo-electric cells.</p> <p>Bauhaus artists László Moholy-Nagy, Oskar Fischinger and Paul Arma experiment with modifying the physical contents of record grooves.</p>
1933	The film <i>King Kong</i> uses manipulated recorded sounds for dramatic effect.	EMI, using Blumlein's stereo patents, cut a stereophonic master disk with both channels in one groove at 90 degrees apart.	Edgard Varèse writes to both the Guggenheim foundation and Bell Labs attempting, unsuccessfully, to secure funding for an electronic music studio.
1934		Laurens Hammond develops the Hammond Electric Organ.	
1936			<p>Percy Grainger and Edgard Varèse separately experiment with record manipulation to create music.</p> <p>Edgard Varèse publishes his manifesto, <i>The Liberation of Sound</i>.</p>
1937	<p><i>War of the Worlds</i> (radio drama) was directed by Orson Welles and deceives its audience that a Martian invasion had begun.</p> <p>Olivier Messiaen composes <i>Fete des Belles Eaux</i> (for Ondes Martenot), composed for the Paris International Exhibition, the famous piece from the suite is <i>Oraison</i>.</p>	First radio telescope <i>dish</i> antenna built by amateur astronomer Grote Reber.	<p>Harald Bode creates the polyphonic Warbo Formant Organ in Berlin.</p> <p>John Cage writes the essay <i>The Future of Music: CREDO</i> predicting the electronic future.</p> <p>Carlos Chávez publishes <i>Toward a New Music</i>, one of the first books to speak of electronic music.</p> <p>Yvgeny Murzin starts designing the ANS Synthesizer in Moscow, to use optical waveforms to synthesize</p>

			sound.
1938	Johanna Beyer composes <i>Music of the Spheres</i> (for three electric glissando instruments or strings and triangle).	Konrad Zuse completes the Z1, a mechanical binary programmable calculator, first binary calculator.	Harald Bode creates the Melodium, a monophonic touch sensitive keyboard instrument.  Percy Grainger publishes his 'free music' statement, predicting music without fixed scales and rhythms.
1939	John Cage performs <i>Imaginary Landscape No 1</i> , the first performance to include live electronics (turntables & test-tone records).	World War II starts.	
1940	<i>Fantasia</i> film released by Walt Disney Productions with a form of stereo surround sound named 'Fantasound', using three source tracks, a sophisticated, pilot-tone automated, mixing and panning system, and 5 to 54 speakers for cinema playback.	Pilot tone tape and film synchronisation is developed in Germany.	Edgard Varèse writes a letter to Hollywood studios suggesting they set-up an Optical Sound Studio.
1943		High-quality, stereo, magnetic tape recorder developed. ( <a href="#">note 2</a> )  The Colossos, first programmable electronic calculator, is used in England to break the ENIGMA code.	
1944	Halim El-Dabh composes <i>Ta'abir al-Zaar</i> (for wire recorder), there is now an excerpt available titled <i>Wire Recorder Piece</i> .		Grainger-Cross Free Music Machine (graphical, optical control of synthesis) developed by Percy Grainger and Burnett Cross, using eight oscillators and synchronizing equipment in conjunction with photo-sensitive graph paper to turn drawn lines into sound.
1945		German, high-quality, tape recorder technology spreads to the USA and Europe as the USA takes German tape recorder patents as part of	

		war booty. World War II ends and the atomic bomb is developed and used.	
1946		ENIAC, the USA's first electronic programmable calculator, is completed.	Raymond Scott develops a large-scale electronic (analog) synthesizer and electro-mechanical sequencer machine in New York, and receives a patent for an electronic 'orchestra machine'.
1947		John Bardeen, Walter Brattain and William Shockley develop the solid-state transistor at Bell Labs.	Hugh Le Caine begins developing the Electronic Sackbut electronic instrument.
1948	Pierre Schaeffer creates <i>Étude aux Chemins de Fer</i> , the first piece of musique concrète, presented in a radio concert in October with his other pieces <i>Étude aux Piano (I &amp; II)</i> , <i>Étude aux Tourniquets</i> , and <i>Étude aux Casseroles</i> (all for analog disk playback).	Manchester Mark 1 (Baby) - the first stored-programme computer - runs its first program and is commercialized as the Ferranti Mark I.  Harry Chamberlin builds tape-playback instrument, a precursor of the modern sampler.  Long Playing records become the standard consumer music format.  Claude E. Shannon founds information theory with the publication of 'A Mathematical Theory of Communication'.	Pierre Schaeffer establishes Club d'Essai (RTF).  Music for Magnetic Tape project created by Louis and Bebe Baron in New York.  Norman McLaren painstakingly draws optical waveforms on film soundtracks.
1951	Louis and Bebe Barron compose <i>Heavenly Menagerie</i> (for tape).  John Cage starts working on <i>Williams Mix</i> (for multi-channel tape) and composes <i>Imaginary Landscape #4</i> (for twelve radios).  Bernard Herrmann uses theremins as the main instrument in the orchestral score for the film <i>The Day the</i>	Tape recorders become available in the US through Army Surplus Stores (Ampex).  UNIVAC I released, the first general purpose computer - designed to handle both numeric and textual information.  Whirlwind, the first real-time 'computer', is built by the Massachusetts Institute of Technology (MIT) for the US	Columbia Tape Music Studio started by Otto Leuning and Vladamir Ussachevsky at Columbia University, New York.  CSIRAC (0.0005 MIPS <a href="#">note 3</a> ) plays in real-time some standard, popular, tunes of the day - the first computer to play music. ( <a href="#">note 4</a> )  Ferranti Mark1 computer plays music (popular melodies) and is recorded by the BBC in

	<p><i>Earth Stood Still.</i></p> <p>Pierre Schaeffer and Pierre Henry compose <i>Symphonie pour un homme seul</i> (for multiple unsynchronized analog disks), played back with spatialization via the 'potentiometre d'espace'.</p> <p>Vladimir Ussachevsky composes <i>Transposition, Reverberation, Experiment, Composition, and Underwater Valse.</i></p>	<p>Air Defence System.</p>	<p>Manchester-the oldest surviving recording of a computer playing music.</p> <p>Percy Grainger develops the Kangaroo Pouch Machine for 'free music'.</p> <p>Groupe de Recherches de Musique Concrète (GRMC) founded at the RTF, Paris (France), and develops the Phonogène for directly manipulating sounds on analog tape.</p> <p>Jikken Kobo (Experimental Workshop) founded in Tokyo by Joji Yuasa, Toru Takemitsu, and other composers and artists.</p> <p>WDR (Westdeutscher Rundfunk - West German Radio) Studio für Elektronische Musik founded by Herbert Eimert, Robert Beyer and Werner Meyer-Eppler in Köln, Germany.</p>
<p>1952</p>	<p>John Cage completes <i>Williams Mix</i> (for unsynchronized multi-channel tape) and composes <i>4'33"</i>.</p> <p>Herbert Eimert and Robert Beyer compose <i>Klangstudie I</i> (for tape).</p> <p>Herbert Eimert composes <i>Klangstudie II</i> (for tape).</p> <p>Karel Goeyvaerts composes <i>Nummer 4 met dode tonen</i> (for tape).</p> <p>Otto Luening composes <i>Fantasy in Space.</i></p> <p>Olivier Messiaen composes <i>Timbres Durees</i> at GRM.</p> <p>Karlheinz Stockhausen composes <i>Etude.</i></p> <p>Vladimir Ussachevsky composes <i>Sonic Contours.</i></p>	<p>ILLIAC I computer is built at the University of Illinois.</p> <p>Optical fiber results from experiments by physicist Narinder Singh Kapany in the USA.</p> <p>Transistor radios first demonstrated.</p>	<p>GRM creates the a three-head tape recorder permitting the synchronization of three tapes, the first synchronized polyphonic multitrack playback.</p> <p>Pierre Schaeffer publishes two texts; <i>À la recherche d'une musique concrète</i> (In search of a concrete music) and <i>L'objet musical</i> (The musical object).</p> <p>Vladimir Ussachevsky presents an electronic music concert, with five of his experimental compositions at the Museum of Modern Art (New York).</p>

<p>1953</p>	<p>Herbert Eimert composes <i>Struktur 8</i> (for tape).</p> <p>Pierre Henry composes <i>Voile d'Orphée</i> (for tape).</p> <p>Karel Goeyvaerts composes <i>Nummer 5 met zuivere tonen</i> (for tape, at the WDR Studio für Elektronische Musik).</p> <p>Karlheinz Stockhausen composes <i>Studie I</i> (for tape).</p>	<p>IBM 701 shipped (its 1st large computer based on vacuum tubes), and its first magnetic tape device.</p> <p>Les Paul commissions Ampex to build an eight-track tape recorder.</p> <p>James D. Watson and Francis Crick publish a paper that correctly described the double-helix model of DNA structure.</p>	<p>Composer-Tron (analog synthesizer with graphic control) developed by Osmond Kendall for the Marconi Company in Canada.</p> <p>The GRM organizes a festival of mostly electronic music, the First Ten Days of Experimental Music, at UNESCO, Paris.</p> <p>Melochord completed by Harald Bode, for the WDR Köln studio, it was used by Werner Meyer-Eppler and Herbert Eimert among others (it appears on Ligeti's <i>Glissandi</i> in 1957).</p> <p>Phonogène (chromatic version and sliding version) is developed at the GRM and the morphophone tape-based multiple delay machine is started.</p>
<p>1954</p>	<p>Mauricio Kagel uses sounds and tape as part of his sonorization for an industrial exhibition in Mendoza.</p> <p>Karlheinz Stockhausen composes <i>Studie II</i> (for tape).</p> <p>Edgard Varèse composes <i>Déserts</i> (for wind, percussion and tape) and it is premiered a year later, creating a scandal.</p>	<p>IBM 704 (0.0064 MIPS) introduced with the first IBM operating system.</p> <p>IBM completes the specification for the first high-level computer language, FORTRAN (FORMula TRANslation).</p>	<p>NHK electronic music studio established in Tokyo, Japan by Toshio Mayuzumi.</p>
<p>1955</p>	<p>Hugh Le Caine composes <i>Dripsody</i> (for tape) using a recording of a single drip of water as the only sound source.</p> <p>Gottfried Michael Koenig composes <i>Klangfiguren I</i> (for tape).</p> <p>Toshiro Mayuzumi composes <i>Music for Sine Waves by Proportion of Prime Numbers, Music for Modulated Waves by Proportion of Prime Numbers,</i></p>	<p>Ampex releases the first commercial eight-track tape recorder.</p> <p>Hugh Le Caine builds the Special Purpose Tape Recorder, a multi-tape playback instrument, a precursor of the sampler, it had six tapes which could be synchronized for playback, later expanded to ten, and a large DC motor for almost instantaneous speed changes.</p>	<p>David Caplin and Dietrich Prinz program a Ferranti Mark1* to start investigating the generation of musical structures by programming it to perform Mozart's <i>Musikalisches Würfelspiel</i>.</p> <p>Columbia University Electronic Music Center established by Otto Luening and Vladimir Ussachevsky.</p> <p>Lejaren Hiller and Leonard Isaacson start work on the</p>

	<p>and <i>Invention for Square Waves and Sawtooth Waves</i> (all for tape).</p> <p>Iannis Xenakis premieres <i>Metastaseis</i> (for orchestra).</p> <p>Iannis Xenakis publishes <i>The Crisis of Serial Music</i>, criticizing serial composition.</p>		<p><i>Illiad Suite</i> - first computer composition experiments.</p> <p>RCA Mark I Synthesizer developed by Harry Olson and Herbert Belar at RCA Princeton labs.</p> <p>Studio di Fonologia Musicale of the RAI in Milan is founded by Luciano Berio and Bruno Maderna.</p> <p>Tempophon or 'Springer machine' released in Germany, a tape machine add-on allowing independent time and pitch changes on analog tape via a rotating head block and electro-mechanical sound granulation.</p>
1956	<p>Louis and Bebe Barron produce <i>Forbidden Planet</i> (tape, for film) and the film of the same name is released, the first with an all-electronic soundtrack.</p> <p>Gottfried Michael Koenig composes <i>Klangfiguren II</i> (for tape).</p> <p>Karlheinz Stockhausen completes <i>Gesang der Jünglinge</i> (for five-track tape, with one track unsynchronized, later reduced to four synchronized tracks), combining concrete and electronic musical elements.</p> <p><i>Push Button Bertha</i>, a popular song resulting from a program written for a Datatron computer by Martin L. Klein and Douglas Bolitho of the Burroughs Corporation, airs on the television program <i>Adventure Tomorrow</i> of KABC-TV Los Angeles.</p>	<p>Ampex releases the first commercial videocassette recorder.</p>	<p>The Centre for Electronic Music is established at the Philips Research Laboratories.</p>
1957	<p>Bülent Arel composes <i>Music for String Quartet and Oscillator</i> (for string quartet</p>	<p>EMT release the Model 140 Plate Reverb device, the first commercial plate reverb.</p>	<p>ANS Synthesizer is completed in Moscow by Yvgeny Murzin, using optical reading of sine</p>

	<p>and electronics).</p> <p>Kid Baltan (Dick Raaijmakers) composes <i>Song of the Second Moon</i> (for tape).</p> <p>György Ligeti composes <i>Glissandi</i> (for tape).</p> <p>Gottfried Michael Koenig composes <i>Essay</i> (for tape).</p> <p>Karlheinz Stockhausen premieres <i>Gruppen</i> (for three orchestras).</p> <p>Iannis Xenakis premieres <i>Pithoprakta</i> (for orchestra).</p>	<p>IBM introduces the first compiler for FORTRAN.</p> <p>Sputnik 1, the first Earth satellite is launched.</p>	<p>waves on 5 glass discs to provide 1/6 semitone pitch resolution over 10 octaves.</p> <p>Lejaren Hiller and Leonard Isaacson complete the <i>Illiad Suite</i>.</p> <p>Max Mathews writes MUSIC I - the first computer sound synthesis program, using pre-determined digitally synthesized waveforms and a 'digital-to-sound' convertor - first musical use of a DAC.</p> <p>RCA Mark II Synthesizer developed (with digital control of analog synthesis) by Harry Olson and Herbert Belar at RCA Princeton labs, originally to electronically generate popular music.</p> <p>Taller Experimental de Sonido (Experimental Sound Workshop) established at the Catholic University in Santiago, Chile.</p> <p>Warsaw Polish Radio establishes the Experimental Studio.</p>
1958	<p>José Vicente Asuar composes <i>Variaciones Espectrales</i> (for tape).</p> <p>Luciano Berio composes <i>Thema-omaggio a Joyce</i> (for tape) and <i>Sequenza I</i> (for flute).</p> <p>John Cage composes <i>Fontana Mix</i> (for tape).</p> <p>Luc Ferrari composes <i>Étude aux sons tendus</i> (for tape).</p> <p>György Ligeti composes <i>Artikulation</i> (for tape).</p> <p>Louis De Meester composes <i>Incantations</i> (for stereo tape).</p> <p>Philips Pavilion opens in Brussels with Edgard Varèse's</p>	<p>Digital Equipment Corporation (DEC) founded.</p> <p>First integrated circuits developed at Texas Instruments.</p> <p>LISP language developed by James McCarthy.</p> <p>Stereo records introduced.</p>	<p>BBC Radiophonic Workshop founded by Daphne Oram and Desmond Briscoe. Mostly famous for the electronic sounds in television shows such as Doctor Who.</p> <p>Cooperative Studio for Electronic Music is privately established at Ann Arbor, Michigan, by Robert Ashley and Gordon Mumma.</p> <p>Columbia-Princeton Electronic Music Center founded from the Tape Music Studio at Columbia University.</p> <p>Estudio de Fonología Musical of the University of Buenos Aires founded by Francisco Kröpfl.</p>

	<p><i>Poème électronique</i> and Iannis Xenakis's <i>Concrèt PH</i> (both for tape), incorporating synchronized playback of images and dynamic spatialization of three-track sound over 425 loudspeakers via sprocketed tape.</p> <p>Toru Takemitsu composes <i>Dialogue</i> (for tape).</p> <p>Vladimir Ussachevsky composes <i>Linear Contrasts</i> (for tape).</p> <p>Iannis Xenakis composes <i>Analogiques A</i> (for string ensemble).</p>		<p>Groupe de Recherches Musicales (GRM) forms from the previous GRMC at RTF, Paris.</p> <p>Studio Für Elektronische Musik founded in Munich by Siemens AG.</p> <p>University of Illinois Electronic Music Studio founded.</p> <p>José Vicente Asuar founds the Electronic Music Studio in Chile.</p>
1959	<p>Halim El-Dabh composes <i>Leiyala and the Poet</i> (for tape) at the Columbia-Princeton EMC.</p> <p>Tom Dissevelt composes <i>Drifting</i> and <i>Vibration</i> (for tape).</p> <p>Mauricio Kagel completes <i>Transición II</i> (for piano, percussion and two tape recorders).</p> <p>Francisco Kröpfl composes <i>Ejercicio de texturas</i> and <i>Ejercicio con Impulsos</i> (both for tape).</p> <p>Dick Raaijmakers composes <i>Tweeklank</i> (for tape).</p> <p>Iannis Xenakis completes <i>Analogiques A &amp; B</i> (for four-channel tape and string ensemble), the first granular synthesis study.</p>	<p>Motorola produces the two-way, fully transistorized mobile radio.</p> <p>Computer companies start delivering transistorized computers, the 'second generation' machines.</p>	<p>Columbia-Princeton Electronic Music Center receives the RCA Mark II Synthesizer.</p> <p>Daphne Oram at the BBC Radiophonic Workshop creates 'Oramics', which uses drawings on ten 35mm sprocketed clear films to control synthesis parameters via photo-electric cells.</p> <p>East German Radio and Television (RFZ) starts experimenting with electronic music and sound production, in East Berlin, German Democratic Republic (GDR - East Germany).</p> <p><i>Experimental Music</i> by Lejaren Hiller and Leonard Isaacson published, the first book presenting an application of scientific method to music.</p> <p>Raymond Scott develops the Electronium, a large-scale electronic (analog) composition machine which is 'guided' rather than played, and the Clavivox, a keyboard instrument with adjustable portamento using a beat-frequency-oscillator arrangement like the theremin.</p>

			<p>Siemens Synthesizer developed by Helmut Klein and W.Schaaf in Munich, similar to the RCA Synthesizer, it was a modular composition and synthesis system that generated musical sequences and synthesized and recorded the results.</p> <p>University of Toronto Electronic Studios founded.</p> <p>Wurlitzer releases the Side Man, the first commercial electronic 'drum machine'.</p>
1960	<p>Bülent Arel composes <i>Stereo Electronic Music No. 1</i> (for tape) using the RCA Synthesizer.</p> <p>Luciano Berio completes <i>Visage</i> (for tape) and <i>Momenti</i> (for four-track tape).</p> <p>John Cage completes <i>Cartridge Music</i> (for phono cartridges with foreign objects replacing the 'stylus' and small sounds amplified contact microphones).</p> <p>Anestis Logothetis completes <i>Fantasmata</i> (for stereo tape) at the Institut für Elektroakustik der Musikhochschule Wien (assisted by Helmut Gottwald).</p> <p>Andrzej Markowski composes the sound for the film <i>The Silent Star</i> at the Experimental Music Studio in Warsaw.</p> <p>Luigi Nono composes <i>Omaggio a Emilio Vedova</i> (for four-track tape).</p> <p>Raymond Scott composes an electronic soundtrack for a <i>Vicks Medicated Cough Drops</i> television commercial.</p> <p>Karlheinz Stockhausen completes <i>Kontakte</i> (two</p>	<p>AT&amp;T announces its Dataphone, the first commercial modem.</p> <p>IBM 7090 ships (fully transistorized mainframe).</p> <p>First weather satellite launched.</p>	<p>MUSIC III completed by Max Mathews, the first modular unit-generator music synthesis language.</p> <p>Studio voor elektronische muziek (STEM) is founded in Utrecht University with the gift of the Philips studio.</p> <p>University of Toronto Electronic Studios opened.</p>

	<p>versions; for electronic sounds and sound projection - the first true quadraphonic work, and for electronic sounds, piano and percussion).</p> <p>Vladimir Ussachevsky composes <i>Wireless Fantasy</i> (for tape).</p>		
1961	<p>Bülent Arel composes <i>Music for a Sacred Service Postlude</i> (for tape).</p> <p>Merce Cunningham premieres <i>Aeon</i> (ballet) with music by John Cage.</p> <p>Roman Haubenstock-Ramati completes <i>Liaison</i> (for stereo tape) at the Institut für Elektroakustik der Musikhochschule Wien (assisted by Helmut Gottwald).</p> <p>György Ligeti's <i>Atmosphères</i> is premiered (for orchestra).</p> <p>Ivo Malec composes <i>Reflets</i> (for tape).</p> <p>Max Mathews composes <i>The Second Law</i> (for computer synthesized tape), a study using pitched and unpitched noises for the first time.</p> <p>James Tenney composes <i>Analogue #1: Noise Study</i> (for tape) using computer synthesized noise and <i>Collage No. 1 (Blue Suede)</i> (for tape) by sampling and manipulating a famous Elvis Presley recording.</p> <p>Horacio Vaggiano composes <i>Ensayo sobre mezcla de sonidos, Cemeronia</i> and <i>Cantata I</i> (for tape).</p>	<p>The first industrial robot, UNIMATE, began work at General Motors.</p> <p>Edward Lorenz discovers a simple mathematical system with chaotic behaviour and publishes it in 1963, leading to the new mathematics of chaos theory which is widely applicable.</p>	<p>Harald Bode develops frequency shifters and ring modulators for the Columbia-Princeton Electronic Music Center.</p> <p>Experimental Music Studio founded at the Norway Broadcasting Commission (Norsk Rikskringkasting - NRK) in Oslo.</p> <p>Israel Center for Electronic Music opens at the Hebrew University, founded by Joseph Tal.</p> <p>Max Mathews and Joan Miller use physical-modelling synthesis in MUSIC IV to create <i>Daisy Bell</i> (a.k.a. <i>Bicycle built for two</i>) vocal synthesis on an IBM 704 (vocal tract physical model by Bell Labs researchers John Kelly and Carol Lochbaum).</p> <p>Ramon Sender, Terry Riley and Pauline Oliveros, create an improvised electronic music 'studio' in the attic of the San Francisco Conservatory of Music and begin a series of concerts called Sonics.</p> <p>James Tenney, a recognized composer, joins Bell Labs to work with Max Mathews.</p>
1962	<p>Friedrich Cerha composes <i>Spiegel V</i> (for stereo tape and orchestra) at the Institut für Elektroakustik der</p>	<p>Bell Labs mass produce transistors and professional amplifiers.</p>	<p>Electronic Music Studio developed by Erkki Kurenniemi for The Institute of Musicology at the University of Helsinki.</p>

	<p>Musikhochschule Wien.</p> <p>Gottfried Michael Koenig composes <i>Terminus 1</i> (for tape).</p> <p>Luigi Nono composes <i>Djamila Boupachá</i> (for soloists and orchestra).</p> <p>Nam June Paik's composes <i>Fluxusobjekt</i> (for fixed tape and hand-controlled tape playback head).</p> <p>James Tenney composes <i>Four Stochastic Studies</i> (for computer-synthesized tape).</p> <p>Iannis Xenakis completes the <i>ST</i> series of works (for string quartet, ensemble and orchestra) using his stochastic composition computer programme and also completes <i>Bohor</i> (for eight-track tape).</p>	<p>Students at MIT develop the first interactive computer game, <i>SpaceWar</i>.</p>	<p>Institut voor Psychoakoestiek en Elektronische Muziek (IPEM) opens in Ghent (Belgium), under the directorship of Louis De Meester.</p> <p>Laboratory of the Centro Latinoamericano de Altos Estudios Musicales (CLAEM) of the Di Tella Institute, Argentina, is founded by Alberto Ginastera.</p> <p>The San Francisco Tape Music Center is founded by Morton Subotnick, Ramon Sender and others from the Sonics group.</p> <p>Studio für künstliche Klang and Labor für Akustisch-Musikalische Grenzprobleme (laboratory for problems at the acoustics / music interface) established in East Berlin, German Democratic Republic (GDR - East Germany) via the RFZ (East German Radio).</p> <p>James Tenney writes the PLF2 program (used to write <i>Four Stochastic Studies</i>, <i>Ergodos</i> and other works).</p> <p>Iannis Xenakis completes his Stochastic Music Program on an IBM 7090, resulting in the <i>ST</i> series of pieces.</p>
1963	<p>Friedrich Cerha composes <i>Und Du</i> (for stereo tape) at the Institut für Elektroakustik der Musikhochschule Wien.</p> <p>Delia Derbyshire creates the theme for the BBC television show <i>Doctor Who</i> (for tape), from composer Ron Grainer's notes.</p> <p>Louis De Meester composes <i>Ringvariaties for piano</i> (for piano and electronic sounds).</p> <p>Pierre Henry composes <i>Variations pour Une Porte et</i></p>	<p>Compact Cassette (analog tape format) introduced by Philips.</p>	<p>Harald Bode develops new designs for his frequency shifter and ring modulator, to be made under licence to R.A.Moog Co.</p> <p>Donald Buchla creates modular analog synthesizers for the San Francisco Tape Music Center.</p> <p>The GRM develops the 'universal' phonogène, an update of the earlier phonogènes allowing independent time and pitch</p>

	<p><i>Un Soupir</i> (for stereo tape).</p> <p>Toru Takemitsu composes <i>Arc</i> (for piano, orchestra and electronic sounds).</p>		<p>changes on analog tape through the use of the tempophon (Springer machine) add-on for tape recorders.</p> <p>IPEM (Institut vor Psychoakoestiek en Elektronische Muziek) founded as a joint venture between the Belgian Radio and Television broadcasting company (BRT) and Ghent University, in Ghent, Belgium.</p> <p>Subharchord, an electronic keyboard instrument making sound by mixing sub-harmonics, developed in East Berlin, German Democratic Republic (GDR - East Germany).</p> <p>Max Mathews introduces MUSIC IV.</p> <p>Robert Moog and Herbert Deutsch start developing an analog synthesizer.</p>
1964	<p>Milton Babbitt completes <i>Philomel</i> (for soprano and tape), serializing all elements of the composition, and <i>Ensembles for Synthesizer</i> (for tape).</p> <p>İlhan Mimaroğlu composes <i>Le Tombeau d'Edgar A. Poe</i> (for tape) using a recording of Mallarmé's poem as the source and <i>Bowery Bum</i> (for tape).</p> <p>Luigi Nono composes <i>La fabbrica illuminata</i> (for voice and tape).</p> <p>Dick Raaijmakers composes <i>Canon I</i> and <i>Canon II</i> (for tape), the beginning of his important series of <i>5Canons</i> exploring how different ways of repeating a single electrical impulse may be used to develop musical structure.</p> <p>Giacinto Scelsi composes <i>String Quartet No.4</i> (for string</p>	<p>ASCII standard introduced.</p> <p>BASIC (Beginners All-purpose Symbolic Instruction Code) computer language is developed at Dartmouth College.</p> <p>Cosmic microwave background (CMB) radiation is discovered by radio astronomers Arno Penzias and Robert Wilson.</p> <p>First computer mouse is prototyped after being invented the previous year by Douglas Engelbart.</p> <p>IBM introduces the System/360.</p>	<p>John Chowning and David Poole start working with Music IV at Stanford University on an IBM 7090.</p> <p>Gottfried Michael Koenig takes over STEM in Utrecht (with Frank de Vries) giving it a new direction, and writes Project 1, for aleatoric serial composition.</p> <p>McGill University Electronic Music Studio (EMS) founded in Montreal by Itsvan Anhalt.</p> <p>Stockholm Elektronmusikstudion (EMS) is founded.</p>

	<p>quartet and electronics).</p> <p>La Monte Young completes <i>A Well Tuned Piano</i> (for just-intuned solo piano).</p> <p>Karlheinz Stockhausen composes <i>Mikrophonie I</i> (for amplified and live-electronic processed tam-tam).</p>		
1965	<p>Mario Davidovsky composes <i>Electronic Study No. 3, In Memoriam Edgar Varèse</i> (for tape).</p> <p>Milan Knizak creates <i>Destroyed Music</i> by manipulating phonograph records through scratching, breaking or cutting and reassembling them, putting holes in them and so on.</p> <p>Alvin Lucier composes <i>Music for Solo Performer</i> (for live electronics) the first live electronics piece to use amplified alpha brainwaves.</p> <p>İlhan Mimaroğlu composes <i>Agony</i> and <i>Görsel Çalışma</i> (both for tape).</p> <p>Pauline Oliveros composes <i>Bye Bye Butterfly</i> (for tape).</p> <p>Steve Reich composes <i>It's Gonna Rain</i> (for tape),</p> <p>Karlheinz Stockhausen composes <i>Solo</i> (for melody instrument and variable electronic tape feedback loop).</p>	<p>First computer art exhibition, at the Technische Hochschule in Stuttgart.</p> <p>Control Data release the CD6600, the first supercomputer.</p> <p>J. W. Cooley of IBM and John W. Tukey of Princeton publish a paper reinventing the fast Fourier transform (FFT) algorithm and describing how to perform it conveniently on a computer.</p> <p>DEC PDP-8 released.</p> <p>Dolby A noise reduction system introduced.</p>	<p>Institute of Electronic Music is founded in Graz, Austria by Heinz Höning.</p> <p>MUSIC IV B developed at Princeton University, making it easier to use by composers rather than scientists, and this becomes MUSIC IV BF when rewritten in FORTRAN for the IBM System/360.</p> <p>Robert Moog's company releases its first commercial voltage-controlled modular analog synthesizer.</p>
1966	<p>Dave Behrman completes <i>Wave Train</i> (piano resonance with feedback).</p> <p>Luciano Berio completes <i>Sequenza III</i> (for female voice).</p> <p>Herbert Brün composes <i>Non Sequitier VI</i> (for tape).</p> <p>Luigi Nono completes <i>A</i></p>	<p>E-mail applications arrive for users on closed, proprietary, networks.</p>	<p>Alea Studio in Madrid established by Luis de Pablo (closed in 1977).</p> <p>François Bayle becomes director of the GRM.</p> <p>Center for Electronic and Computer Music (CECM) established in Paris and at</p>

	<p><i>floresta é jovem e cheia de vida</i> (for soprano, three recitants, clarinet, copper plates and eight-track tape).</p> <p>Karlheinz Stockhausen completes <i>Hymnen</i> (for four-track tape).</p> <p>Iannis Xenakis completes <i>Terretektorh</i> (for large orchestra spread out in space).</p> <p>Seok Hee Kang composes <i>Wonsaegui Hyangyeon (The Festival of Colors)</i>, for tape) at the Korean Broadcasting Station.</p>		<p>Indiana University, by Iannis Xenakis.</p> <p>François Coupigny prototypes the 'Coupigny' synthesizer and the Studio 54 mixing desk at GRM, Paris - final versions are developed over the next few years, completed in 1969.</p> <p>Electronic Music Studio founded at Victoria University in Wellington (NZ) by Douglas Lilburn.</p> <p>Estudio de Fonología Musical of Instituto Nacional de Cultura y Bellas Artes (INCIBA) founded in Venezuela.</p> <p>Gottfried Michael Koenig writes Project 2 computer composition program, allowing greater control over the composition process.</p> <p>Musica Elettronica Viva (MEV), a live-electroacoustic (free) improvisation group, formed in Rome, Italy.</p>
1967	<p>The Grateful Dead release <i>Anthem of the Sun</i> and Frank Zappa and the Mothers of Invention release <i>Uncle Meat</i> both records make extensive use of electronic manipulation.</p> <p>Leon Kirchner composes <i>String Quartet No. 3</i>, the first piece with electronics to win the Pulitzer Prize.</p> <p>Jan W. Morthenson completes <i>Neutron Star</i> (for tape from computer generated sounds).</p> <p>Gordon Mumma composes <i>Hornpipe</i> (for french horn with reed mouthpiece and electronic feedback and processing) incorporating electronic responses to the amplified resonances of the performance hall.</p> <p>Bernard Parmegiani composes</p>	<p>A timecode system, originally developed to track missiles, is adapted for videotape to identify individual frames of video - becoming the SMPTE (Society of Motion Picture and Television Engineers) standard, used to synchronise tape recorders and also video and film playback, replacing multiple previous proprietary systems and still in use.</p>	<p>Hugh Le Caine builds the Serial Sound Structure Generator (SSSG), a complex analog sequencer (using square waves) for serial music, delivered to McGill University in 1970/71.</p> <p>John Chowning accidentally discovers frequency modulation (FM) synthesis when experimenting with extreme vibrato effects in MUSIC-V.</p> <p>Electronic Music Studio founded at the Royal College of Music, London by Tristram Cary.</p> <p>The San Francisco Tape Music Center moves to the Mills College Center of Contemporary Music.</p> <p>STEM at Utrecht University</p>

	<p><i>Capture éphémère</i> (for tape).</p> <p>Dick Raaijmakers composes <i>Canon V</i> (for tape), completing the <i>Canon</i> series.</p> <p>Morton Subotnick composes <i>Silver Apples of the Moon</i> (title from a Yeats poem), the first large-scale work commissioned specifically for the LP record (Nonesuch).</p> <p>Iannis Xenakis completes <i>Polytope de Montréal</i> (for four small orchestras and light installation for Expo 67).</p>		<p>changes its name to the Institute of Sonology.</p> <p>STEIM is formed in Amsterdam.</p>
1968	<p>Robert Ashley completes <i>Purposeful Lady Slow Afternoon</i> (for tape).</p> <p>John Cage and Lejaren Hiller compose <i>HPSCHD</i> (for up to seven harpsichords and up to fifty-one tapes).</p> <p>Wendy Carlos releases <i>Switched on Bach</i> (record).</p> <p>Luigi Nono composes <i>Contrappunto dialettico alla mente</i> (for tape).</p> <p><i>Spectraphonia</i> (sound and light show) takes places in Montréal, using a light-organ accompaniment for Berio's <i>Sinfonia</i>, especially recorded for 12-channel playback.</p> <p>Karlheinz Stockhausen completes <i>Stimmung</i> (for six amplified vocalists).</p> <p>David Tudor composes <i>Rainforest I</i> (for amplified mechanically-transformed sounds of small objects) as a sound-score for Merce Cunningham.</p> <p>Vladimir Ussachevsky composes <i>Computer Piece No. 1</i> (for tape).</p>	<p>TEAC introduces the Simul-Sync 4-Tracks recorder, the first consumer multi-track tape deck.</p>	<p>Can, an experimental electroacoustic free improvisation group, formed in Cologne, Germany.</p> <p>Estudio de Música Electrónica de Barcelona established by Andrés Lewin-Richter.</p> <p><i>Leonardo Journal of the Arts, Science and Technology</i> first published.</p> <p>MUSIC V released and written in FORTRAN so it is ported to many different computers.</p> <p>Jean-Claude Risset at Bell Labs creates a catalog of sound synthesis with MUSIC V instruments.</p> <p>Lejaren Hiller joins the Computer Music Studios in the University at Buffalo (The State University of New York).</p>

<p>1969</p>	<p>Luciano Berio composes <i>Sinfonia</i> (for eight amplified voices and orchestra).</p> <p>Lars-Gunnar Bodin completes <i>Toccata</i> (for tape).</p> <p>John Cage and Lejaren Hiller compose <i>HPSCHD</i> (for seven harpsichords, fifty-two tape recorders playing random computer-generated 'tunes' in fifty-two different tuning systems, fifty-two film projectors and sixty-four slide projectors).</p> <p>Mario Davidovsky composes <i>Synchronisms No. 5</i> (for percussion and tape).</p> <p>Luc Ferrari composes <i>Music Promenade</i> (for four-channel tape) from manipulated field recordings, originally as a sound installation for four unsynchronized tape recorders.</p> <p>Toshi Ichiyanagi composes <i>Tokyo 1.9.6.9</i> (for tape).</p> <p>Gottfried Michael Koenig composes <i>Funktion Blau, Funktion Indigo, Funktion Violett, Funktion Grau</i> (for tape).</p> <p>Bruno Maderna composes <i>Quadrivium</i> (for percussion quartet and orchestra).</p> <p>Iannis Xenakis composes <i>Kraanerg</i> (dance work for orchestra and four-track tape).</p>	<p>First ARPANET (Advanced Research Projects Agency Network) links between the University of California at Los Angeles, University of California at Santa Barbara, University of Utah and also including the (private) Stanford Research Institute - the beginnings of the internet.</p> <p>First model of the DEC PDP-15 family of computers is released.</p> <p>Digital tape recording experiments begin.</p> <p>Neil Armstrong becomes the first person to walk on the Moon.</p> <p>RS232 serial communication standard developed.</p> <p>Unix developed by Ken Thompson and Dennis Ritchie at Bell Labs.</p>	<p>Don Buchla releases commercial modular analog synthesizers.</p> <p>CEMS (Coordinated Electronic Music Studio) System installed in the Electronic Music Studio at the State University of New York at Albany.</p> <p>Electronic Music Studio established at The University of Adelaide, Australia.</p> <p>Salvatore Martirano begins development of his Sal-Mar Construction, a 24-channel analog/digital real-time performance synthesizer, at the University of Illinois.</p> <p>Max Mathews and F. Richard Moore build the GROOVE synthesizer, the first digital control of analog synthesis.</p> <p>Peter Zinovieff forms Electronic Music Studios (London) Ltd., and his activities include using a PDP-8 to control analog synthesis in MUSYS (ver. I-III by Peter Grogono) composition software and releasing the VCS3 (Putney) analog synthesizer using a pin matrix instead of patch cords and a joystick for real-time control.</p>
<p>1970</p>	<p>Bülent Arel composes <i>Stereo Electronic Music No. 2</i> (for tape).</p> <p>César Bolaños composes <i>Sialoecibi</i> (for piano and one reciter-mime-actor), and <i>Canción sin palabras</i> (for piano with two performers and tape).</p>	<p>ARPANET expands with more connected locations.</p> <p>First of the DEC PDP-11 family released.</p> <p>The first version of the UNIX operating system runs on a DEC PDP-7.</p> <p>Lexicon releases the Delta T-</p>	<p>Digital Music Instrument - Associative memory (DIMI-A), and others, developed by Erkki Kurenniemi for the Electronic Music Studio at the University of Helsinki, allowing realtime control through touch, brainwave and visual gestures.</p> <p>Lejaren Hiller and Pierre Ruiz research and develop general</p>

	<p>Mario Davidovsky composes <i>Synchronisms No. 6</i> (for piano and tape) and is awarded the Pulitzer Prize for it in 1971.</p> <p>Charles Dodge completes <i>Earth's Magnetic Field</i> (for tape) mapping magnetic field data into musical parameters.</p> <p>Hans Werner Henze composes <i>Violin Concerto No. 2</i> (for orchestra and tape, using MUSYS).</p> <p>Kraftwerk emerge as the first fully electronic pop band.</p> <p>Alvin Lucier completes <i>I Am Sitting in a Room</i> (for tape).</p> <p>Charles Wuorinen composes <i>Times Encomium</i> (for tape) the first Pulitzer Prize winner for an entirely electronic work.</p> <p>Kurt Wigger completes <i>Resa</i> (for tape).</p> <p>Iannis Xenakis completes <i>Hibiki-Hana-Ma</i> (for twelve-track tape).</p>	<p>101 the first digital delay unit.</p> <p>First Random Access Memory (RAM) integrated circuit released by Intel.</p>	<p>physical modeling synthesis.</p> <p>Electronic Music Lab established at Mexico's National Conservatory of Music.</p> <p>Institut de Recherche et Coordination Acoustique/Musique (IRCAM) is founded and planning started.</p> <p>Princeton 'Underground Laboratory' Electronic Music Studio established by Godfrey Winham and Ken Steiglitz.</p>
1971	<p>Harrison Birtwistle composes <i>Chronometer</i> (for tape, using MUSYS).</p> <p>Emmanuel Ghent completes <i>Phosphones</i> (for tape, on GROOVE).</p> <p>Hans Werner Henze composes <i>Glass Music</i> (for tape, using MUSYS).</p> <p>alcides lanza composes <i>plectros III</i> (for piano and synthesized sounds).</p> <p>Karlheinz Stockhausen completes <i>Mantra</i> (for two pianists, sine wave generators, ring-modulators and tape).</p> <p>Richard Teitelbaum creates <i>Alpha Bean Lima Brain</i> involving the transmission of</p>	<p>C computer language is developed by Brian Kernighan and Dennis Ritchie of Bell Laboratories.</p> <p>DEC PDP-11/45 released (0.76 MIPS).</p> <p>Denon demonstrates 18-bit PCM (pulse code modulation) digital stereo recording with a video recorder.</p> <p>First microprocessor is developed, the Intel 4004.</p>	<p>Electroacoustic Studios founded at Concordia University, Montréal, by Kevin Austin.</p> <p>Electronic Music Studio at the Academy of Music and Dance in Jerusalem founded by Tzvi Avni.</p> <p>FM synthesis developed to synthesize musical instrument sounds by John Chowning.</p> <p>SSP (sound synthesis program) designed by Gottfried Michael Koenig for real-time digital instruction synthesis.</p> <p>University of Natal, Durban, South Africa Electronic Music Studio opens.</p>

	<p>brain waves by telephone to control jumping beans.</p> <p>Iannis Xenakis completes <i>Persèpolis</i> (for 8-track tape).</p>		<p>Barry Vercoe rewrites MUSIC 360 (a derivative of MUSIC IV) to port it to the PDP-11 at MIT, and improves it, creating MUSIC 11.</p>
1972	<p>Françoise Bayle completes <i>L'Expérience Acoustique</i> (for tape), the first piece to use the 123 software.</p> <p>John Chowning completes <i>Turenas</i> (for four-channel tape) using FM synthesis and doppler effects in the spatilaization.</p> <p>Charles Dodge completes <i>Speech Songs</i> (for computer synthesized tape).</p> <p>DJ Kool Herc, at parties in New York, develops a turntable technique to extend rhythmic parts of a recorded song and establishes the musical foundations of hip-hop.</p> <p>Pink Floyd releases <i>The Dark Side of the Moon</i> (LP record), making extensive use of synthesizers, and with short musique concrète interludes between songs.</p> <p>György Ligeti composes <i>Double Concerto</i> (for flute, oboe and orchestra).</p> <p>Kurt Wigger completes <i>Sommarmorgon</i> (for tape).</p> <p>Iannis Xenakis completes <i>Polytope de Cluny</i> (for eight-track tape with a computer-controlled light show), and it opens in Paris.</p>	<p>ARPANET widely introduced.</p> <p>First e-mail is sent and an open e-mail application demonstrated.</p> <p>IBM introduces the 8-inch floppy disk.</p> <p>Intel 8008 introduced, first commercial 8-bit microprocessor.</p> <p>Philips demonstrates an optical videodisc system.</p> <p>Technics release the first direct-drive turntable, the SL-1200, which later becomes the industry standard for disc jockeys.</p>	<p>Centre d'Etudes de Mathematiques et Automatiques Musicales (CEMAMu), is founded near Paris by Iannis Xenakis.</p> <p>Centro de Investigaciones en Communication Massiva, Artes y Tecnologia (CICMAT) established in Buenos Aires from CLAEM studio.</p> <p>Composers Inside Electronics collective founded by John Driscoll, Ralph Jones, Martin Kalve, and David Tudor for the composition and performance of electronic and electro-acoustic music.</p> <p>EMS 1, a music and synthesis specification language running on a PDP-15, is completed at the Stockholm EMS.</p> <p>Herbert Brün starts work on the SAWDUST stochastic synthesis software.</p> <p>Salvatore Martirano completes the 'Sal-Mar Construction', featuring 291 lighted touch-sensitive switches which are used by the performer to create a complex of musical sounds, distributed to 24 separate speakers.</p> <p>Barry Truax develops POD4 and POD5 (fixed waveform synthesis) for the PDP-15 at the Institute of Sonology.</p>
1973	<p>Paul Lansky composes <i>mild und leise</i> (for tape).</p> <p>David Tudor creates <i>Rainforest IV</i> (for spatially mixed live sounds of</p>	<p>Ethernet and the Alto workstation computer developed at Xerox Palo Alto Research Center (PARC).</p> <p>First ARPANET international</p>	<p>Electro-Acoustic Music Studio established at the Cracow Academy of Music.</p> <p>Estudio de Fonología Musical of Instituto Nacional de Cultura y</p>

	<p>suspended sculptures and found objects).</p>	<p>connection (to Europe).  First mobile phone call made.  Part of UNIX is rewritten in the C language.</p>	<p>Bellas Artes (INCIBA) re-established in Venezuela.  Gmebaphone (tape music spatialization system) created at GMEB, Bourges, France.  IMPAC, a a realtime digital audio control environment using joystick, keyboard and digitizer tablet, is developed at the Stockholm EMS by Michael Hinton.  Stan Templaars and W. Kaegi develop VOSIM synthesis at Sonology.  Barry Truax develops POD6 for real-time monophonic digital FM synthesis.  MIT Electronic Music Studios (EMS) established, to become part of MIT Media Lab in 1985.  STEIM focuses on electronic music performance with the arrival of Michel Waiswiz.</p>
<p>1974</p>	<p>Pauline Oliveros completes, <i>Sonic Meditations</i> (for voices and other sounds).  Giacinto Scelsi composes <i>Aitsi</i> (for electronically prepared piano).  First International Computer Music Conference (ICMC), Michigan, USA.</p>	<p>Intel releases its 2 MHz 8080 CPU chip (0.6 MIPS).  Mellotron is built, first commercial instrument 'sampler' with a keyboard playing loops of analog tape.  TCP (network Protocol) proposed as common network transport, first use of the word 'Internet'.  X.25 networking common in U.K. universities.  Xerox PARC designs a computer with a mouse.</p>	<p>Acousmonium (tape music spatialization system) created by Françoise Bayle at GRM, Paris.  Ambisonics (spatial audio reproduction) developed by Michael Gerzon, Peter Fellgett and Duanne Cooper.  Electronic Music Studio at the Rubin Academy of Music at Tel-Aviv University established by Yizhak Sadai.  Estudio de Música Electrónica de Barcelona becomes Phonos Studio, Barcelona established by J.M.Mestres Quadreny, L.Callejo, A.Lewin-Richter and G.Brncic.  Curtis Roads implements granular synthesis using MUSIC V.  Yamaha licenses frequency</p>

			modulation synthesis from John Chowning.
1975	<p>Milton Babbitt completes <i>Phonemena</i> (version for soprano and tape).</p> <p>Paul Berg composes <i>Merriweather's Guide to Plants and People</i> (for tape, using ASP).</p> <p>Luciano Berio completes <i>Chants parallèle</i> (for tape).</p> <p>Annea Lockwood composes <i>World Rhythms</i> (for tape with real-time spatialization).</p> <p>İlhan Mimaroğlu completes <i>Tract</i> (tape).</p> <p>Bernard Parmegiani completes <i>De Natura Sonorum</i> (for tape).</p> <p>Larry Polansky composes <i>Four Voice Canon #2</i> (for tape).</p>	<p>Altair 8800 microcomputer released, first mass-produced microcomputer and computer kit.</p> <p>EMT releases the first digital reverb unit.</p> <p>Mitchell Feigenbaum discovers a new mathematical constant (approx. 4.67...), related to period-doubling bifurcations and it plays an important part in chaos theory.</p> <p>Homebrew Computer Club formed in San Francisco.</p> <p>Benoît Mandelbrot publishes 'Les Objets Fractals, Forme, Hasard et Dimension' describing the theory of fractals.</p> <p>Micro-Soft (later Microsoft) founded.</p> <p>MOS Technology (later Commodore) KIM-1 microcomputer released. (0.2 MIPS)</p>	<p>Automated Synthesis Programs (ASP), a kind of instruction synthesis, started by Paul Berg at the Institute of Sonology.</p> <p>Center for Computer Research in Music and Acoustics (CCRMA) founded at Stanford University by John Chowning, James A. Moorer, John Grey and Loren Rush.</p> <p>Electronic Music and Video Studios established at La Trobe University, Melbourne, Australia by Warren Burt.</p> <p>Syter 1 (synthèse en temps réel - real time synthesis) real-time DSP system development started at the GRM by Jean-François Allouis.</p> <p>Princeton 'Underground Laboratory' becomes the Winham Sound Laboratory.</p> <p>Synclavier prototype of working all-digital synthesizer.</p> <p>Michel Waiswiz develops the Cracklebox synthesizer.</p>
1976	<p>Luciano Berio composes <i>Coro</i> (for forty voices and orchestra).</p> <p>Herbert Brün composes <i>Dust</i> (for computer-generated tape).</p> <p>Brian Ferneyhough completes <i>Time and Motion Study II</i> (for amplified cello, tape delay system, and modulators).</p> <p>Philip Glass premieres <i>Einstein at the Beach</i> (a multimedia opera for ensemble, chorus and soloists).</p> <p>Bruce Pennycook composes <i>if</i></p>	<p>Apple Computer Company founded.</p> <p>Cray 1 released, the first commercial supercomputer (64-bit and 150 MIPS).</p> <p>Digital Equipment Corporation introduces the DEC VAX 11/780, a popular minicomputer (0.5-1 MIPS).</p> <p>Viking I and II land on Mars and send back the first images.</p> <p>VHS videotape system developed.</p>	<p>Dave Behrman uses a KIM-1 in performance of <i>On the Other Ocean</i> at Mills College.</p> <p>Paul Berg develops the PILE synthesis language for real-time instruction synthesis on a PDP-15 at the Institute of Sonology.</p> <p>Fairlight CMI prototype, Quasar M8 built by Tony Furse, working.</p> <p>Giuseppe Di Giugno develops the 4A synthesizer at IRCAM.</p> <p>Jim Horton uses a KIM-1 in performance at the</p>

	<p><i>carillons grew wings</i> (for tape).</p> <p>Steve Reich composes <i>Music for 18 Musicians</i> (for ensemble and four female voices).</p> <p>Denis Smalley composes <i>Darkness After Time's Colours</i> (for tape).</p> <p>Barry Vercoe composes <i>Synapse</i> (for viola and computer).</p> <p>Iannis Xenakis composes <i>Psappha</i> (for solo percussion).</p>		<p>Exploratorium in San Francisco.</p> <p>Roland release the System-700 modular analog synthesizer, Japan's first commercial modular synthesizer system.</p> <p>Laurie Spiegel creates the VAMPIRE system for real-time video and sound composition.</p>
1977	<p>Françoise Bayle premieres <i>Crystal</i> (for tape), the first piece to use the SYTEM prototype.</p> <p>Luc Ferrari completes <i>Presque Rien N°2</i> (for tape).</p> <p>Francisco Kröpfl composes <i>Nocturno</i> and <i>Scherzo</i> (both for tape).</p> <p>György Ligeti composes <i>Le Grand Macabre</i> (opera).</p> <p>Gareth Loy composes <i>Nekyia</i> (for four-track tape, rendered on the Samson Box)</p> <p>Alvin Lucier completes <i>Music on a Long Thin Wire</i> (for amplified wire and electromagnetic excitor).</p> <p>Larry Polansky composes <i>Four Voice Canon #3</i> (for computer synthesized tape).</p> <p>Trevor Wishart completes <i>Red Bird: A Political Prisoner's Dream</i> (for tape).</p> <p>David Wessel composes <i>Anthony</i> (for tape).</p> <p>Iannis Xenakis completes <i>La Legende d'Eer</i>. (for synchronized seven-track tape).</p>	<p>Apple II released, using a 6502 CPU at 1MHz (0.23 MIPS).</p> <p>BSD Unix released.</p> <p>Commodore PET microcomputer released.</p> <p>Solid State Logic release the SL 4000, the first commercial automated music mixing console.</p> <p>Soundstream Digital Recording System released, the first commercial digital recording system.</p> <p>Space Shuttle 'Enterprise' first test flight.</p> <p>Tandy announces the TRS-80 microcomputer.</p>	<p>Laurie Anderson creates the Tape Bow Violin instrument, using magnetic tape in place of hair on a violin bow.</p> <p>The Computer Music Journal is first published in Menlo Park, California.</p> <p>Digital control of analog studio at the Institute of Sonology.</p> <p>IRCAM is opened.</p> <p>George Lewis plays with an improvising KIM-1 at Mills College.</p> <p>Roland release the MC-8 MicroComposer, the first 8 channel, digital microprocessor-controlled, control-voltage sequencer, with FSK (frequency shift keying) tape synchronization.</p> <p>Peter Samson completes the Systems Concepts Digital Synthesizer (a.k.a. Samson Box), a MUSIC IV implementation in hardware controlled by a PDP10, for CCRMA at Stanford.</p> <p>Iannis Xenakis, at CEMAMu, develops functioning UPIC.</p>

<p>1978</p>	<p>Paul Berg composes <i>I Never Knew You Cared</i> (for tape) using the PILE instruction synthesis program.</p> <p>Brian Eno creates <i>Music for Airports</i>, an ambient music installation.</p> <p>Kraftwerk release <i>The Man-Machine</i> and use robotic mannequins on stage.</p> <p>Paul Lansky composes <i>Six Fantasies on a Poem by Thomas Campion</i> (for computer synthesized tape).</p> <p>Iva Malec completes <i>Triola Ou Symphonie Pour Moi-Même</i> (for tape) at GRM.</p> <p>Luigi Nono composes <i>Con Luigi Dallapiccola</i> (for percussion and electronics).</p> <p>Tamas Ungvary composes <i>Axionell II</i> (for tape).</p> <p>Iannis Xenakis completes <i>Mycenae-Alpha</i> (for tape) first piece composed completely on the UPIC, and opens <i>Le Diatope</i> in Paris with <i>La Legende d'Eer</i> (1977) synchronized to a computer-controlled laser light show.</p>	<p>Atari 800 microcomputer released, using a 6502 CPU at 1.8MHz (0.4 MIPS).</p> <p>5.25-inch floppy disks become an industry standard.</p> <p>Stereo PCM audio adaptors for VCR tape recorders introduced.</p> <p>TCP splits into TCP/IP, and allows for the creation of UDP (User Datagram Protocol), a network protocol designed for low delay and useful for streamed data.</p>	<p>William Buxton has the SSSP software on a PDP-11 controlling sixteen digital oscillators.</p> <p>Electronic Music Studio founded at Seoul National University by Sung Ho Hwang, but there is no official program.</p> <p>Di Giugno completes the 4C synthesizer.</p> <p>Jean-François Allouis and others at GRM start developing the Studio 123 sound transformation software programs for a PDP-11/60.</p> <p>League of Automatic Music Composers formed by Jim Horton, John Bischoff and Rich Gold.</p> <p>MOUSE composition and synthesis control software for microcomputers is developed from MUSYS by Peter Grogono.</p> <p>Synclavier enters production.</p>
<p>1979</p>	<p>Robert Ashley completes <i>Automatic Writing</i> (for tape).</p> <p>Françoise Bayle composes <i>Eros Bleu</i> (for tape), the first piece to use the 123 software.</p> <p>John Cage composes <i>Roaratorio</i> (for electronic tapes, speaker and Irish folk musicians).</p> <p>Iannis Xenakis completes <i>Pleides</i> (for six percussionists).</p>	<p>CompuServe offers electronic mail to personal computer users.</p> <p>Motorola 68000 microprocessor introduced (1 MIPS at 8MHz).</p>	<p>The International Computer Music Association (ICMA) is founded by Thom Blum, Curtis Roads and John Strawn.</p> <p>Fairlight CMI I released.</p> <p>Merzbow starts the Lowest Music and Arts record label to release his music on cassette.</p> <p>F.Richard Moore founds the Computer Audio Research Lab at the University of California at San Diego, and also develops the software CMUSIC.</p> <p>Sony releases the TPS-L2 "Walkman" portable cassette</p>

			<p>player, the first mass-market portable music player.</p> <p>TASCAM Portastudio is released, bringing multi-track (4-channel) recording on cassettes to the mass-market.</p>
1980	<p>Clarence Barlow completes <i>Çogluotobüsisletmesi</i>, (versions for piano, and computer rendition).</p> <p>Charles Dodge composes <i>Any Resemblance Is Purely Coincidental</i> (for piano and tape).</p> <p>Trevor Wishart completes <i>Anticredos</i> (for six amplified voices and percussion).</p>	<p>EMT release the first commercial digital hard-disk audio recorder.</p> <p>Multitrack digital tape recorders introduced.</p> <p>Sinclair ZX80 microcomputer released.</p> <p>TCP/IP accepted as superior network protocol for the Internet.</p> <p>Technics 1200 turntable released and becomes the standard DJ turntable.</p>	<p>FOF formant synthesis, and the CHANT program developed at IRCAM by Xavier Rodet, Yves Potard and Jean-Baptiste Barrière.</p> <p>The <i>Computer Music Journal</i> moves to the MIT Press, legitimizing computer music research.</p> <p>Sequential Drum gesture controller is developed at IRCAM by Max Mathews.</p> <p>Dean Wallraff releases the DMX-1000 Digital Signal Processor, a micro-programmable DSP system with DAC.</p>
1981	<p>Larry Austin composes <i>Canadian Coastlines: Canonic Fractals for Musicians and Computer Band</i> (for instruments and tape).</p> <p>Pierre Boulez premieres <i>Répons</i> (for ensemble and live electronics).</p> <p>Herbert Brün composes <i>i toLD You so!</i> (for computer-generated tape).</p> <p>Nicolas Collins composes <i>Second State</i> (for microcomputer controlled feedback).</p> <p>David Rosenboom completes <i>Departure</i> (for SATB voices).</p> <p>MTV starts on commercial television.</p>	<p>3.5-inch floppy disks released by Sony.</p> <p>IBM PC introduced, using an Intel 8088 CPU at 4.77MHz (0.33 MIPS).</p> <p>First computer optical storage disk system introduced by Philips.</p> <p>Pacman computer game released.</p> <p>First normal launch of the Space Shuttle, 'Columbia' flies an orbital test flight.</p>	<p>Estúdio da Glória established in Rio de Janeiro, Brazil.</p> <p>Gabinete de Música Electrónica de Cuenca established in Cuenca, Spain, with a Synthi 100.</p> <p>Giuseppe Di Giugno completes the 4X synthesizer.</p> <p>MTV (music television) is launched.</p> <p>Yamaha GS1 and GS2 digital synthesizers released.</p>

<p>1982</p>	<p>Nicolas Collins composes <i>Is She/He Really Going Out With Him/Her/Them</i> (for circuits, radios, prepared tapes and computer-controlled mixer).</p> <p>David Jaffe composes <i>Silicon Valley Breakdown</i> (for computer generated sound) using an early version of Karplus-Strong synthesis on the Samson Box.</p> <p>Gottfried Michael Koenig composes <i>3 ASKO Pieces</i> (for small orchestra).</p> <p>Annea Lockwood composes <i>A Sound Map of the Hudson River</i> (for tape).</p> <p>Iva Malec composes <i>Week-end</i> (for tape)</p> <p>Philippe Manoury composes <i>Zeitlauf</i> (for choir, 14 instruments and electronics).</p> <p>Luigi Nono composes <i>Donde estas hermano?</i> (for two sopranos, mezzo-soprano and contralto) and <i>Quando stanno morendo</i> (for female voices, cello, bass flute and live electronics).</p> <p>Dennis Smalley composes <i>Vortex</i> (for tape).</p>	<p>Acorn BBC Micro computer released.</p> <p>Bell Labs at Murray Hill publishes a paper discussing touch-screen based computer interfaces.</p> <p>Commodore 64 computer released (0.25 MIPS).</p> <p>First CD released.</p> <p>Benoît Mandelbrot publishes 'The Fractal Geometry of Nature', developing the theory of fractal geometry more fully.</p> <p>Sony releases the PCM-F1, a consumer adaptor for VCRs for high-quality (CD-quality) stereo digital recording.</p> <p>Space Shuttle flies its first mission.</p> <p>Sun Microsystems founded and releases the SUN 1 workstation (0.5 MIPS).</p> <p>University of Toronto develops the first finger pressure multi-touch display.</p>	<p>Birmingham ElectroAcoustic Sound Theatre (BEAST, tape music spatialization system) is created.</p> <p>E-mu Emulator commercial sampler synthesizer released.</p> <p>HMSL (Hierarchical Music Specification Language) music programming language released by Phil Burk, Larry Polansky and David Rosenboom (for an S-100 computer controlling a Buchla synthesizer).</p> <p>Laboratorio de Investigación y Producción Musical (LIPM) established in Buenos Aires from the CICMAT studio.</p> <p>James A. Moorer completes the Audio Signal Processor (a.k.a. SoundDroid) at Lucasfilm Droid Works, which was used for sound production on films such as <i>Return of the Jedi</i> and the Lucasfilm THX audio logo in 1984.</p>
<p>1983</p>	<p>Jean-Baptiste Barrière composes <i>Chréode</i> (for computer-generated tape).</p> <p>François Bayle composes <i>Le Sommeil d'Euclide</i> (for tape).</p> <p>Luigi Nono composes <i>Omaggio a György Kurtág</i> (for contralto, flute, clarinet, tuba and live electronics) and <i>Guai ai gelidi mostri</i> (for two voices, ensemble, and live electronics).</p> <p>Roger Reynolds completes <i>Archipelago</i> (for large ensemble and eight-channel</p>	<p>ARPANET converts to TCP/IP protocol - the modern Internet backbone is created.</p> <p>ARPANET splits into MILNET (for military communications) and ARPANET (for civilian applications).</p> <p>Fiber-optic cable is used for long-distance audio transmission.</p> <p>First CD players released worldwide.</p> <p>IBM PC/XT released (0.25 MIPS).</p>	<p>MIDI 1.0 specification released.</p> <p>First MIDI synthesizers appear.</p> <p>Kevin Karplus and Alex Strong, along with David Jaffe and Julius O. Smith, develop an efficient physical modeling algorithm for plucked string synthesis.</p> <p>Yamaha releases DX7 FM synthesizer-first mass-market all-digital synthesizer, with MIDI.</p>

	<p>computer-generated tape).</p> <p>Jean-Claude Risset composes <i>L'autre Face</i> (for soprano and tape).</p> <p>Karlheinz Stockhausen completes <i>Samstag Aus Licht</i> (opera).</p> <p>Tamas Ungvary composes <i>Gypsy Children's Giant Dance with Ili Fourier</i>. (for ensemble and computer sounds).</p>	<p>Silicon Graphics Incorporated (SGI) release the IRIS 1000 graphics workstation.</p>	
1984	<p>Clarence Barlow composes <i>Im Januar am Nil</i> (for chamber orchestra), simulating vowel sounds.</p> <p>Luciano Berio composes <i>Sequenza X</i> (for trumpet and piano resonance) and <i>Orpheo II</i> (opera for voice, orchestras, and tapes).</p> <p>Paul Lansky composes <i>Idle Chatter</i> (for computer-synthesized tape).</p> <p>Mesias Maiguashca composes <i>Fmelodies II</i> (for ensemble and tape).</p> <p>Luigi Nono composes <i>A Pierre</i> (for contrabass flute, contrabass clarinet and electronics) and <i>Guai ai Gelidi Mostri</i> (for ensemble, voices and live electronics).</p> <p>Bernard Parmegiani composes <i>La Creation Du Monde</i> (for tape).</p> <p>Jean Claud Risset composes <i>Sud</i> (for tape).</p> <p>Yasunao Tone begins performing with 'wounded' CDs through the application of perforated Scotch tape.</p>	<p>Apple Macintosh released (68000 processor, 0.7 MIPS).</p> <p>Bell Labs engineers a multi-touch screen that can manipulate images with more than one hand.</p> <p>CD-ROM computer storage introduced.</p> <p>William Gibson's <i>Neuromancer</i> novel is published.</p> <p>Sony introduces the first portable CD player.</p> <p>TCP/IP starts spreading to Europe.</p>	<p>Roger Dannenberg and Barry Vercoe demonstrate automatic accompaniment at the ICMC.</p> <p>GRM completes the Syter 3 real-time DSP system.</p> <p>Paul Lansky develops CMIX.</p> <p>Platypus workstation plug-in DSP card completed.</p> <p>Roland release the MPU-401 MIDI processing unit and interface - an 'intelligent' MIDI interface with FSK sync for tape.</p> <p>Steinberg GmbH is founded and releases Pro-16 multitrack MIDI sequencer.</p> <p>Yamaha releases the CX5M Music Computer (Z80 based), with built-in FM synthesis modules and composition software.</p> <p>Michel Waisvisz develops The Hands controller.</p> <p>MIDIForth MIDI composition software released.</p> <p>Waseda University (Tokyo) designs Wabot-2, a piano playing robot that reads scores.</p>
1985	<p>Lars-Gunnar Bodin composes <i>Anima</i> (for female voice and tape).</p>	<p>Atari 520ST released (0.5 MIPS).</p>	<p>Les Ateliers UPIC is founded in Paris by Iannis Xenakis, with pedagogy and musical creation</p>

Denis Lorrain composes ...  
*Black It Stood As Night* (for tape).

Salvatore Martirano composes  
*Sampler: Everything Goes When the Whistle Blows* (for violin and yahaSALmaMAC).

Luigi Nono completes  
*Prometeo* (for multiple orchestras, two conductors, narrators, spatially placed groups of instrumental and vocal soloists, and live electronic sound distribution).

Pauline Oliveros composes  
*Wanderer* (for accordion orchestra).

Jean-Claude Risset composes  
*Sud* (for four-track tape).

David Rosenboom completes  
*Zones of Influence* (for percussion and electronics).

Kaija Saariaho completes  
*Jardin Secret I* (for tape).

Giacinto Scelsi composes  
*String Quartet No.5* from *Aitsi* (for string quartet and electronics).

Denis Smalley composes  
*Clarinet Threads* (for amplified clarinet tape).

Horacio Vaggione completes  
*Thema* (for amplified bass saxophone and computer-generated tape).

Commodore Amiga 1000 computer released (0.5 MIPS).

Digital mixing consoles are released.

Microsoft releases Windows 1.0.

NeXT computer company founded.

as its primary aims, promoting the research of CEMAMu, especially the UPIC System, and to teach professionals and amateurs alike to use the UPIC.

Electronic music labs established at the Escuela Superior de Música del Instituto Nacional de Bellas Artes (INBA) and at Centro Independiente de Investigación y Multimedia (CIIM), Mexico.

Ensoniq Mirage sampler released, first generally affordable sampling keyboard instrument.

The HUB (interactive, networked, computer improvisation group) formed.

Kyma environment released for Platypus.

George Lewis starts work on Voyager for Macintosh.

Laboratorio de Música Electrónica de la Escuela Guridi Vitoria established in Vitoria, Spain, designed by Eduardo Bautista.

MacMix created at IRCAM by Adrian Freed to graphically edit sound on a Macintosh connected to a VAX 11/780.

MIT Media Lab is founded.

John Oswald uses the term 'plunderphonics' in an essay titled 'Plunderphonics, or Audio Piracy as a Compositional Prerogative'.

Sound Designer software released first for the Emulator II.

Laurie Spiegel develops Music Mouse.

Barry Vercoe reimplements MUSIC 11 as Csound at MIT.

<p>1986</p>	<p>Richard Karpen composes <i>Eclipse</i> (for computer-created sound).</p> <p>Gottfried Michael Koenig composes <i>Beitrag</i> (for orchestra).</p> <p>Bernard Parmegiani composes <i>Exercisme 3</i> (for tape), the first major piece with the Syter 3 system.</p> <p>Larry Polansky composes <i>Four Voice Canon #6</i> (for computer, samples and baritone saxophone) and <i>B'rey'sheet</i> (for voice and interactive computer).</p> <p>Trevor Wishart completes <i>Vox 5</i> (for tape).</p>	<p>CDs outsell LP records.</p> <p>Dolby SR noise reduction system introduced.</p> <p>R-DAT (digital audio tape) specification released and machines released in Japan.</p> <p>First RISC (reduced instruction set computing) computers introduced by IBM and MIPS Technologies.</p>	<p>Akai S900 sampler released and becomes a mass-market sampling module.</p> <p>Clarence Barlow creates Autobusk, algorithmic composition software for the Atari ST.</p> <p>CMU MIDI Toolkit programming library released by Roger Dannenberg of Carnegie Mellon University.</p> <p>Music Box MIDI algorithmic composition software released.</p> <p>Nicolas Collins creates <i>Trombone Propelled Electronics</i>, trombone-based DSP controller.</p> <p>Composers Desktop Project (CDP) started with porting CMUSIC to an Atari ST.</p> <p>The Computer and Electronic Music Studio founded in Beijing by Yuanlin Chen.</p> <p>Electroacoustic Music Studios established at the Escola Superior de Música of Lisbon (ESML) by Antonio de Sousa Dias.</p> <p>FURT electronic music duo forms.</p> <p>Miller Puckette develops a non-graphical program (precursor of Max) at IRCAM to control the 4X synthesizer.</p> <p>Institute of Sonology moves from Utrecht University to the Royal Conservatory of The Hague, Netherlands.</p> <p>MacMix program released (first DAW), allowing a Macintosh to graphically edit sound using external DSP hardware named Dyaxis II.</p> <p>Music Kit music and DSP programming library released by NeXT Computer.</p>
-------------	--	---	---

			<p>SoundEdit released for the Macintosh by MacroMind, the first audio timeline editor (4 tracks maximum) with waveform display.</p> <p>Soviet Computer Music Centre established in Moscow.</p> <p>David Zicarelli develops M.</p>
1987	<p>John Adams premieres <i>Nixon in China</i> (opera).</p> <p>Robert Ashley completes <i>el/Aficionado</i> (opera for solo voices, chorus, solo piano and electronics).</p> <p>Richard Karpen composes <i>Il Nome</i> (for soprano and computer-created sound).</p> <p>Gottfried Michael Koenig composes <i>String quartet 1987</i>.</p> <p>Thierry Lancino completes <i>Aloni</i> (for contralto, boys choir, ensemble, and electronics).</p> <p>Philippe Manoury composes <i>Jupiter</i> (for solo flute and real-time electronics), the first piece to use score following.</p> <p>Luigi Nono composes <i>Post-prae-ludium no. 1 'per Donau</i> (for tuba and live electronics).</p> <p>Bruce Pennycook composes <i>Praescio III</i> (for extended harpsichord, computer and MIDI synthesizers).</p> <p>David Rosenboom completes <i>Systems of Judgement</i> (for computer music systems and various instruments).</p> <p>Carla Scaletti composes <i>sunSurgeAutomata</i> (for tape, realized using the Platypus digital signal processor)</p>	<p>Apple Macintosh II released (68020 processor, 2.6 MIPS).</p> <p>Intel 80386 computers released (2+ MIPS).</p> <p>Consumer DAT decks released.</p> <p>Motorola 68030 microprocessor released (11 MIPS at 33 MHz).</p> <p>Sun Microsystems releases the Sun-4/260 (first SPARC system - 10 MIPS)</p>	<p>C-Lab Creator MIDI sequencer released for Atari.</p> <p>George Lewis completes Voyager software for interactive improvisation.</p> <p>HMSL music programming language becomes widely available on common computers.</p> <p>Laboratorio de Informática y Electrónica Musical del Centro para la Difusión de la Música Contemporánea (LIEM-CDMC) created by Tomás Marco and Adolfo Núñez at Centro Reina Sofía, Madrid.</p> <p>Max Mathews develops the Radio Baton controller.</p> <p>Roland releases the D50 synthesizer, the first affordable unit to combine digital sample playback with digital (subtractive) synthesis.</p>

	<p>Denis Smalley composes <i>Wind Chimes</i> (for tape).</p> <p>Alejandro Viñao composes <i>Toccata del Maga</i>. (for ensemble, samples and real-time electronics).</p>		
1988	<p>John Cage composes <i>Europera</i> (opera; for singers, orchestra, and tape).</p> <p>Mario Davidovsky composes <i>Synchronisms No. 9</i> (for violin and tape).</p> <p>Francisco Kröpfl composes <i>Metrópolis - Buenos Aires</i> (for tape).</p> <p>Philippe Manoury composes <i>Pluton</i> (for midi piano and electronics), the first piece to use Max.</p> <p>Salvatore Martirano composes <i>FOUR NOT TWO</i> (for the yahaSALmaMAC, Zeta Violin and DX7 Keyboard).</p> <p>Kaija Saariaho composes <i>Petals</i> (for cello with live electronics) and <i>Stilleben</i> (for tape).</p> <p>Horacio Vaggione composes <i>Sçir</i> (for bass flute and tape).</p> <p>Iannis Xenakis composes <i>Taurhiphanie</i> (for tape, using UPIC computer generated sounds).</p>	<p>ARPANET and 10% of its computers are partly disabled by the first worm 'virus', which flooded the network and computers.</p> <p>CD sales are greater than LP record sales for the first time.</p> <p>Digidesign Sound Tools I audio accelerator DSP card for Apple Macintosh released.</p> <p>NeXT workstation introduced (15 mips).</p>	<p><i>Finale</i> music notation software is first released.</p> <p>Korg M1 released, first music workstation.</p> <p>Michael Laursen creates PatchWork at IRCAM.</p> <p>Pauline Oliveros founds the Deep Listening Band.</p> <p>Salvatore Martirano completes the 'yahaSALmaMAC' (the successor to the 'Sal-Mar Construction'), combining a Macintosh computer, 25 synthesizers, MIDI keyboard and violin, and Sound and Logic (SAL) software developed by Martirano for live improvisation.</p> <p>Miller Puckette develops Patcher (later called Max) at IRCAM to control the 4X synthesizer.</p> <p>SensorLab (sensor to MIDI interface) development starts at STEIM and occasional prototypes released.</p> <p>Wave Field Synthesis (spatial audio reproduction) theory developed at the University of Delft.</p>
1989	<p>François Bayle composes <i>Mimaméta</i> (for tape).</p> <p>Francis Dhomont composes <i>Novars</i> (for tape) using both the Syter 3 and 123 software.</p> <p>Luigi Nono completes <i>La Lontananza Nostalgica Utopica</i></p>	<p>Intel i486 computers released (8.7 MIPS).</p> <p>Digidesign Audiomedia I DSP and audio I/O card for Apple Macintosh released.</p>	<p>Center for New Music and Audio Technologies (CNMAT) founded at the University of California at Berkeley.</p> <p>Common Music software environment released by Rick Taube.</p>

	<p><i>Futura</i>. (for solo violin, eight tapes and ten music stands).</p> <p>John Oswald releases the <i>Plunderphonic</i> EP record to the press and radio but it is never offered for sale after threats by record companies.</p> <p>Carla Scaletti composes <i>Trinity</i> (for voice and live processing) with Kyma running on the Platypus, premiered at the 1989 ICMC at Ohio State University.</p> <p>Marco Stroppa composes <i>Traiettoria</i> (for piano and computer-generated tape).</p> <p>Horacio Vaggione composes <i>Ash</i> (for tape) using the Syter 3 system.</p>		<p>Digidesign Turbosynth and Sound Tools (DAW) released.</p> <p>Electroacoustic Music Studios established at the Escola Superior de Música of Porto (ESML).</p> <p>Electronic Music program founded at Seoul National University by Sung Ho Hwang, in the previously established studios.</p> <p>Steinberg releases Cubase 1.0 graphical MIDI sequencer for Atari.</p> <p>C-Lab Notator MIDI notation and sequencer released.</p> <p>Opcode Max released.</p> <p>Zentrum für Kunst und Medientechnologie (ZKM) is founded in Karlsruhe.</p>
1990	<p>Ricardo Dal Farra composes <i>Interacciones</i> (for real-time interactive computer generated sounds and images).</p> <p>Paul Lansky composes <i>Night Traffic</i> (for computer-generated tape).</p> <p>Cort Lippe composes <i>Music for Harp and Tape</i>.</p> <p>Bruce Pennycook composes <i>Praescio IV</i> (for clarinet and live computer-controlled MIDI electronics).</p> <p>Takayuki Rai composes <i>Sparkle</i> (for bass clarinet and tape).</p>	<p>Apple IIfx released (10 MIPS).</p> <p>Windows 3.0 released, first commercially successful version.</p> <p>Sony introduces the writeable CD.</p> <p>Dolby proposes five-channel surround sound for home cinema.</p> <p>MPEG-1 Audio Layer III (MP3) becomes a standard.</p>	<p>Don Buchla develops the Thunder controller.</p> <p>Cubase 1.0 sequencer released for Macintosh.</p> <p>ICEM (Institute for Computer Music and Electronic Media) founded at the Folkwang University, Germany.</p> <p>IRCAM ISPW released with MaxFTS.</p> <p>Graphical Kyma software released for updated DSP hardware called Copybara.</p> <p>Flute playing anthropomorphic robot project started at Waseda University.</p> <p>Laboratory for Analysis and Synthesis of Image and Sound (OASIS) founded at the Universidade Federal de Minas Gerais (UFMG) in Brazil.</p> <p>Laboratorio Colombiano de Música Electrónica Jacqueline Nova, first founded in the</p>

			Universidad Autónoma de Manizales, Colombia.
1991	<p>Nicolas Collins creates <i>Broken Light</i> (for string quartet and modified, skipping, CD players).</p> <p>Karel Goeyvaerts composes <i>Aquarius</i> (for instrumental ensemble).</p> <p>Ake Parmerud creates <i>Les objets obscures</i> (for tape) at GRM.</p> <p>Dick Raaijmakers composes <i>Der Leiermann</i> (for tape and hand spooled tape player).</p> <p>Agostino Di Scipio composes <i>Plex</i> (for contrabass and four-channel tape).</p> <p>Iannis Xenakis completes <i>GENDY3</i> (for tape, created solely with dynamic stochastic synthesis).</p>	<p>Alesis ADAT introduced, the first consumer digital multi-track recorder.</p> <p>Apple releases the QuickTime multimedia format and the influential PowerBook series of laptop computers.</p> <p>First World Wide Web software released by CERN (Organisation Européenne pour la Recherche Nucléaire), HTTP protocol developed.</p> <p>Linux project started.</p> <p>Mac OS 7 released.</p> <p>MIPS Computer Systems introduces the first 64-bit microprocessor, the R4000 RISC chip.</p> <p>Python computer language released by Guido van Rossum.</p> <p>SGI Indigo workstation introduced.</p> <p>Sony MiniDisk released.</p> <p>Pierre Wellner publishes a paper on a multi-touch "Digital Desk", which uses multi-finger and pinching gestures.</p>	<p>Buchla develops the Lightning controller.</p> <p>FORMULA (Forth music language) released.</p> <p>Gabinete de Electroacústica para la Música de Arte (GEMA) founded at the University of Chile.</p> <p>GRM Tools first developed for realtime DSP with Sound Designer II hardware.</p> <p>Laetitia Sonami develops first Lady's Glove.</p> <p><i>Leonardo Music Journal</i> first published by MIT Press.</p> <p>Iannis Xenakis completes GENDYN program for dynamic stochastic synthesis.</p> <p>Pro Tools 1 DAW released.</p> <p>Steinberg releases Cubase Audio DAW software.</p> <p>SoundHack DSP sound manipulation software released by Tom Erbe.</p> <p>Symbolic Composer (algorithmic composition software) introduced.</p>
1992	<p>Mario Davidovsky composes <i>Synchronisms No. 10</i> (for guitar and electronic sounds).</p> <p>alcides lanza composes <i>vôo</i> (for actress-singer, electroacoustic sounds and DSP).</p> <p>Bob Ostertag composes <i>All the Rage</i> (for sting quartet and sounds, transcribed from riot recordings).</p> <p>Kaija Saariaho composes <i>Amers</i> (for ensemble and live</p>	<p>Apple introduces the Quicktime media technology.</p> <p>Digidesign Audiomedia II DSP and audio I/O card for Apple Macintosh released.</p> <p>First PowerPC processor (601) released.</p> <p>IBM releases their first ThinkPad laptop computer.</p> <p>C-Lab programmers form Emagic.</p>	<p>AC Toolbox (algorithmic composition software) introduced by Paul Berg.</p> <p>CIME - Research Center for Electroacoustic Music founded at the University of Aveiro, Aveiro Portugal, by Joao Pedro Oliveira.</p> <p>Reed Ghazala publishes articles on 'circuit bending' in the journal <i>Experimental Musical Instruments</i>.</p> <p>Laboratório de Música e</p>

	<p>electronics).</p> <p>Marco Stroppa composes <i>In cielo, in terra, in mare</i> (a radiophonic opera).</p> <p>Horacio Vaggione composes <i>Kitab</i> (for bass clarinet, piano, contrabass and computer processed and controlled sounds).</p>	<p>Windows 3.1 released.</p> <p>Digital Compact Cassette (digital tape format) introduced by Philips and Matsushita.</p> <p>Work begins on RTP (Real Time Protocol) network protocol developed for media streaming.</p>	<p>Tecnologia (LaMuT) established in Rio de Janeiro, Brazil.</p> <p>Lemur DSP sound manipulation software released.</p> <p>SensorLab (sensor to MIDI interface) released by STEIM.</p>
1993	<p>Karlheinz Essl creates <i>Lexikon-Sonate</i> (an interactive real-time composition environment for musical composition and live performance).</p> <p>Cort Lippe composes <i>Music for Sextet and ISPW</i> (for flute, bass clarinet, trombone, violin, cello, piano and computer).</p> <p>Daniel Teruggi composes <i>Sphaera</i> (for tape) and <i>Instants d'hiver</i> (for tape).</p> <p>Laptop Music and Noise Music emerges from the combination of available technology and application of the tools and aesthetic of computer music to more popular ends.</p>	<p>First graphical Web browser application released, Mosaic (later to become Netscape Navigator).</p> <p>Windows NT released.</p>	<p>Emagic Notator Logic MIDI sequencer and DAW released for the Macintosh with Digidesign hardware.</p> <p>The Center for Electroacoustic Music of China founded in Beijing by Zhang Xiaofu.</p> <p>Leonardo Electronic Almanac journal first published by MIT Press.</p> <p>Norwegian Network for Technology, Acoustics and Music (NoTAM) is founded.</p> <p>Sensorband forms.</p> <p><i>Sibelius</i> music notation software is first released (for Acorn computers).</p> <p>Yamaha releases VL1 and VP1 digital physical modelling synthesizers.</p>
1994	<p>Autechre releases <i>Anti-EP</i> an EP record where the third track, <i>Flutter</i>, is composed not to repeat in such a way as to avoid the then-recent UK anti-rave legislation.</p> <p>Philippe Manoury completes <i>En écho</i> (for soprano and live electronics), using score following with phoneme and formant detection.</p> <p>Ake Parmerud completes <i>Grains of Voices</i> (for tape).</p>	<p>Apple switches to PowerPC processors.</p> <p>DVD disks and players introduced.</p> <p>Linux 1.0 released.</p> <p>Netscape Navigator Web browser released.</p> <p>First modern Web search engine appears, WebCrawler.</p> <p>First WWW conference and WWW becoming common.</p>	<p>Emagic releases Logic 4 with Audiowerk interface making DAW software possible without additional DSP hardware.</p> <p>IRCAM introduces AudioSculpt DSP sound manipulation software.</p> <p>Princeton Sound Kitchen formed from the 1970s Winham Lab.</p> <p>SSEYO release the Koan program for generative music</p>

	<p>Bruce Pennycook composes <i>Praescio VII</i> (for piano and computer sounds).</p> <p>Larry Polansky composes <i>Four Voice Canon #9</i> (for tape, using HMSL, Csound and SoundHack).</p> <p>Takayuki Rai composes <i>Kinetic Figuration</i> (for MIDI piano, synthesizer, and computer).</p> <p>Kaija Saariaho composes <i>Six Japanese Gardens</i> (for percussion and electronics).</p> <p>David Tudor creates <i>Soundings: Ocean Diary</i> for Merce Cunningham (live electronic sounds for ballet).</p> <p>Trevor Wishart completes <i>Tongues of Fire</i> (for tape).</p> <p>Iannis Xenakis completes <i>S.709</i> (for tape, created solely with dynamic stochastic synthesis).</p>	<p>Sun Microsystems releases Java 1.0a computer language.</p> <p>Yamaha introduces the first consumer digital mixer.</p>	<p>creation.</p>
1995	<p>Roger Dannenberg composes <i>Nitely News</i> (for ensemble, electronics and computer animation), the first piece with real-time computer-generated music notation.</p> <p>Donnacha Dennehy composes <i>Metropolis Mutabilis</i> (for tape with optional video).</p> <p>Jean Piché composes <i>The Dangerous Kitchen</i> (for voice and interactive computer system).</p> <p>Curtis Roads completes <i>Clang-Tint</i> (for fixed media), using convolution via Soundhack and edited with MacMix.</p> <p>David Rosenboom completes <i>On Being Invisible II</i> (for soloist, brainwaves and computer-assisted electronic music system).</p>	<p>ARPANET renamed as Internet.</p> <p>Intel Pentium Pro computers released (400 MIPS).</p> <p>Internet becomes widely available.</p> <p>Mac OS 7.5 released.</p> <p>Nagra introduces a 'solid-state' audio recorder.</p> <p>RealAudio is released by RealNetworks, the first successful internet audio streaming system.</p> <p>Windows 95 released.</p>	<p>Bar Ilan University Computer Music Laboratory founded in Israel.</p> <p>Clavia Nord Lead synthesizer released, using physical modeling to digitally reproduce analog synthesis.</p> <p>Cynthia (a graphical interface to Csound) released.</p> <p>LiSa (live sampling) software released by STEIM.</p> <p>MISO STUDIO, founded in Lisbon, Portugal, by Miguel Azguime.</p> <p>RTCmix developed from CMIX by Brad Garton (Columbia University) and Dave Topper (University of Virginia).</p>

	<p>Carla Scaletti composes <i>Public Organ</i> (interactive Internet installation) with Kyma running on the Capybara premiered at the 1995 ICMC at Banff.</p>		
1996	<p>Ricardo Dal Farra composes <i>Tierra y Sol</i> (for tape).</p> <p>Mille Plateaux releases <i>In Memoriam Gilles Deleuze</i>.</p>	<p>First experimental recordings made with 24 bits and 96kHz AD and DA converters.</p> <p>RTP (Real Time Protocol) network protocol for media streaming is first published.</p> <p>SGI O2 workstation introduced.</p>	<p>Don Buchla develops Lightning II controller.</p> <p>Cecilia (a graphical companion to Csound, developed from Cynthia) released.</p> <p>Native Instruments releases Generator version 0.96 (synthesis software).</p> <p><i>Organised Sound Journal</i> is first published by Cambridge University Press.</p> <p>PatchWork (algorithmic composition software) introduced.</p> <p>Princeton Sound Lab is formed.</p> <p>Steinberg release VST plug-in software.</p> <p>SuperCollider released by James McCartney.</p> <p>Synthesis Toolkit (STK) software library released by Perry Cook.</p>
1997	<p>Richard Barrett composes <i>Opening of the Mouth</i> (for two vocalists, instrumentalists and electronics).</p> <p>Convolution Brothers perform <i>Gandy Bridge</i> (live computer processing of voice and sounds) at the ICMC in Greece.</p> <p>Gottfried Michael Koenig composes <i>Per Flauti</i> (for two flutes).</p> <p>Maurice Methot and Hector LaPlante start streaming algorithmically generated music live on the internet with <i>The Algorithmic Stream</i>.</p>	<p>Apple Macintosh G3 released (600 MIPS).</p> <p>Mac OS 8 released.</p> <p>DVD-Audio (high resolution digital audio) standard introduced.</p>	<p>Auto-Tune DAW plug-in released by Antares Audio Technologies, bringing real-time pitch manipulation (correction) DSP to commercial music production.</p> <p>AudioMulch released.</p> <p>Cloud Generator granular synthesis software released by John Alexander and Curtis Roads.</p> <p>Coda Music Technology releases Vivace, the first commercial computer-accompaniment system.</p> <p>Csound becomes real-time on</p>

	<p>Takayuki Rai composes <i>Impulse</i> (for percussion and computer).</p> <p>Kees Tazelaar completes <i>Depths of Field</i> (for eight-channel fixed media).</p> <p>Yasunao Tone creates <i>Solo for Wounded CD</i> by damaging and manipulating CDs causing them to skip and distort.</p>		<p>PC hardware.</p> <p>GRM Tools released as VST plug-ins, for realtime DSP in software.</p> <p>Image/ine (image processing and MIDI) software released by STEIM.</p> <p>JSyn, Java sound library, released by Phil Burk.</p> <p>Max/MSP released by David Zicarelli.</p> <p>Nyquist music and synthesis programming environment released by Roger Dannenberg of Carnegie Mellon University.</p> <p>Open Sound Control (OSC) released.</p> <p>Pure Data released by Miller Puckette.</p> <p>Steinberg release VST and ASIO as open standards.</p> <p>Daniel Teruggi succeeds François Bayle as director of the GRM.</p>
1998	<p>Georg Hajdu composes <i>Der Sprung – Beschreibung einer Oper</i> (opera, for narrator, singers, electronic instruments, and ensemble).</p> <p>Cort Lippe composes <i>Music for Hi-Hat and Computer</i> (for Hi-Hat and live DSP).</p> <p>David Rosenboom completes <i>Bell Solaris</i> (for piano).</p> <p>Agostino Di Scipio completes <i>5 Difference-sensitive Circular Interactions</i> (for string quartet and room-dependent signal processing, commission of CEMAT, Rome).</p> <p>Atau Tanaka and Kaspar Toeplitz create the <i>Global String</i> installation, an interactive network instrument</p>	<p>Intel releases the Pentium II processor (800 MIPS)</p> <p>First portable MP3 players introduced.</p> <p>Napster peer-to-peer file-sharing software introduced for easy sharing of MP3 files over the internet for the first time.</p> <p>Windows 98 released.</p>	<p>jMusic, sound library for Java, released.</p> <p>Nanoloop sequencer created for the Nintendo Gameboy by Oliver Wittchow.</p> <p>Native Instruments releases Reaktor (synthesis software).</p> <p>OpenMusic (algorithmic composition software) introduced.</p> <p>Symbolic Sound releases the significantly expanded Copybara 320.</p>

	<p>installation with a virtual and real string.</p> <p>Horacio Vaggione composes <i>Agon</i> (for multichannel tape).</p>		
1999	<p>alcides lanza composes <i>ontem</i> (for actress-singer, tablas, percussion electroacoustic sounds and live DSP).</p> <p>Curtis Roads completes <i>Half-Life</i> (for fixed media).</p> <p>Alejandro Viñao composes <i>Epitafios</i> (for mixed choir and computer).</p>	<p>Apple Macintosh G4 released (825 MIPS).</p> <p>Mac OS 9 released.</p> <p>CD-R drives become standard part in PCs.</p> <p>DVD-Audio (high resolution digital audio) standard finalized.</p> <p>Fingerworks produce several multi-touch products including the iGesture Pad and the TouchStream computer keyboard.</p> <p>Super Audio CD (SACD) high resolution CD format introduced by Sony and Philips.</p> <p>Sony releases commercial hardware convolution (DSP) reverberation processor.</p>	<p>Cubase VST 2 released with VSTi interface for virtual software instruments and synthesizer plug-ins.</p> <p>Dr. Erol Üçer Center for Advanced Studies in Music (MIAM) established in Istanbul.</p> <p>The Music, Technology and Innovation (MTI) Research Centre is founded at De Montfort University, UK.</p> <p>Pro Tools LE released.</p> <p>Sound Description Interchange Format (SDIF) released, allowing high-level sound descriptions (for example, spectral, time-domain or sinusoidal) to be interchanged between sound applications.</p>
2000	<p>Natasha Barrett composes <i>Utility of Space</i> (fixed-media, versions for stereo playback and ambisonic playback).</p> <p>Nicolas Collins coordinates <i>Fiber Jelly</i> for networked computer ensemble, with Justin Bennett, Kaffe Matthews, Scanner, Anne Wellmer, Zeitblom.</p> <p>Brian Ferneyhough completes <i>The Doctrine of Similarity</i> (for voices and ensemble).</p> <p>Jem Finer creates the <i>LongPlayer</i> sound installation to run for a thousand years.</p> <p>Jean Piché composes <i>A Cervantes</i> (for saxophone and interactive computer system).</p>	<p>1GHz Intel Pentium III computers released (1,800 MIPS).</p> <p>Windows ME released.</p>	<p>CSIRAC music reconstructed from the punched-paper program tapes at The University of Melbourne, by Ron Bowles, Paul Doornbusch, Jurij Semkiw and John Spencer.</p> <p>Haifa University Electronic Music Studio founded by Arie Shapira.</p> <p>Lippold Haken releases the Continuum Fingerboard controller.</p> <p>Les Ateliers UPIC changes its name to CCMIX (Center for the Composition of Music Iannis Xenakis) under the directorship of Gerard Pape.</p> <p>Loris DSP sound manipulation software released.</p> <p>Propellerhead Software</p>

	Daniel Teruggi composes <i>The Shining Space</i> (for tape).		releases Reason 1.0 virtual synthesizer / sampler.
2001	<p>Georg Hajdu composes <i>Exit</i> (for violin and electronics).</p> <p><i>Improvised Music from Japan</i> released, showing off the burgeoning Japanese electronic improvisation scene.</p> <p>Gerard Pape composes <i>The Ecstasy of St. Theresa</i> (for nine voices and live electronics).</p> <p>Jean Piché composes <i>eXpress</i> (for fixed-media, three-channel video and stereo sound).</p> <p>Takayuki Rai composes <i>Lucent Aquarelle</i> (for harp and computer).</p> <p>Benjamin Thigpen composes <i>balagan</i> (for eight-channel fixed media).</p> <p>Roger Reynolds completes <i>The Angel of Death</i> (for solo piano, chamber orchestra, and six-channel computer-processed sound).</p> <p>First annual NIME conference, Seattle, Washington, USA.</p>	<p>Advanced Audio Coding (AAC) format introduced by Dolby Labs and Fraunhofer Institute.</p> <p>Apple iPod released.</p> <p>Mac OS X (Unix based) released.</p> <p>Napster peer-to-peer file-sharing servers are temporarily shut down after legal challenges.</p> <p>Real-time convolution reverb in software becomes possible with the commercial release of Altiverb by AudioEase.</p> <p>Windows XP released.</p>	<p>Ableton Live, Version 1 (loop-based sequencer software) released.</p> <p>athenaCL (algorithmic composition software) introduced by Christopher Ariza.</p> <p>Composers Desktop Project 4 released with full functionality and graphical interface.</p> <p>Curtis Bahn develops the SBass controller.</p> <p>Chris Chafe creates the 'Network Harp' which uses network latency for sound synthesis.</p> <p>Electronic Music Studios and program founded at the Korean National University of Art (KNUA) by Sung Ho Hwang in Seoul.</p> <p>Electronic Music Unit (studios) established at The University of Adelaide.</p> <p>JMSL (Java Music Specification Language) music programming language, based on HMSL, is released.</p> <p>Korg release the Triton music workstation synthesizer and the KARMA music workstation synthesizer including generative music capabilities.</p> <p>PulsarSynthesis software released by Alberto de Campo and Curtis Roads.</p>
2002	<p>Paul Doornbusch composes <i>Continuity 3</i>, (for percussion and computer).</p> <p>Jean Piché composes <i>Bharat</i> (for fixed media, three-channel video, and stereo sound).</p>	<p>Apple buys Emagic and takes control of Logic DAW software.</p> <p>Napster is sold to the the German media group Bertelsmann.</p>	<p>JunXion (Sensor to MIDI) software released by STEIM.</p> <p>PWGL (visual music programming environment) released by Mikael Laurson, Mika Kuuskankare, and Vesa</p>

	<p>Kaija Saariaho completes <i>From the Grammar of Dreams</i> (for soprano and mezzo-soprano).</p>		<p>Norilo of the Sibelius Academy, Finland.</p> <p>Shazam mobile phone-based service is launched to automatically recognise music tracks.</p> <p>SuperCollider becomes Open Source.</p> <p>SuperCollider 3 released.</p>
2003	<p>Richard Barrett composes <i>DARK MATTER</i> (for eighteen performers and electronics).</p> <p>Ricardo Dal Farra completes <i>Civilizaciones</i> (for six percussion players and live electronics).</p> <p>Drew Kraus composes <i>Powder</i> (for computer-generated sounds) and <i>Tweety</i> (for flute and computer-generated sounds).</p> <p>alcides lanza composes <i>aXents</i> (for chamber ensemble and computer synthesized sounds).</p> <p>Agostino Di Scipio composes <i>Feedback Study [Audible Ecosystemics n.2]</i> (solo live electronics).</p> <p>Karlheinz Stockhausen completes the opera cycle <i>Licht</i>.</p> <p>Kees Tazelaar composes <i>Sternflüstern</i> (for fixed media).</p>	<p>Apple Macintosh G5 released (3,100 MIPS).</p> <p>Apple introduces iTunes.</p>	<p>Chuck, a strongly timed audio programming language (software), released by Perry Cook and Ge Wang, often used for live coding.</p> <p>Reactable multi-touch instruments development comences at Pompeu Fabra University in Barcelona.</p> <p>Sonic Arts Research Centre (SARC) opens in Belfast.</p>
2004	<p>James Dillon completes <i>Philomela</i> (opera).</p> <p>Brian Ferneyhough completes <i>Shadowtime</i> (opera for soloists, small orchestra, and tape).</p> <p>Ake Parmerud composes <i>La Vie Mécanique</i> (for tape).</p>	<p>iPod becomes dominant portable media player and iTunes the dominant online music distributor.</p>	<p>Apple releases Garageband, consumer DAW software.</p> <p>EmissionControl granular synthesis software released by David Thall.</p> <p>Glunion sensor interface system introduced by Sukandar Kartadinata.</p> <p>Lemur Multi-touch control</p>

			<p>surface released by JazzMutant, a multi-touch controller interface for musical applications.</p> <p>SoundHack Spectral Shapers DSP sound manipulation plug-ins introduced.</p> <p>Symbolic Sound releases Kyma X sound design software.</p>
2005	<p>Curtis Roads completes <i>POINT LINE CLOUD</i> (for fixed media).</p> <p>Agostino Di Scipio completes <i>Background Noise Study (Audible Ecosystemics n.3)</i> (solo live electronics), commission of DAAD, Berlin).</p> <p>Benjamin Thigpen composes <i>0.95652173913</i> (for eight-channel fixed media).</p> <p>Horacio Vaggione completes <i>Taléas</i> (for recorders and electroacoustics).</p>	<p>Apple acquires Fingerworks and their associated multi-touch technology.</p> <p>Mac OS X 10 Server released.</p>	<p>Arduino sensor interface system introduced.</p> <p>Impromptu live coding software released by Andrew Sorensen.</p> <p>IpSonLab (sensor to OSC interface system) introduced by Lex v. d. Broek at Koninklijk Conservatorium in the Netherlands.</p> <p>Princeton Laptop Orchestra (PLOrk) founded.</p> <p>Reactable multi-touch instrument released and demonstrated at the ICMC in Barcelona.</p> <p>SPEAR phase vocoder (DSP) software released.</p> <p>Symbolic Sound releases Kyma X sound design software.</p> <p>Zenph studios develop software to transcribe polyphonic piano recordings into high-resolution (XP) MIDI files, allowing re-recordings of famous historical performances with a Yamaha Disklavier Pro.</p>
2006	<p>Natasha Barrett composes <i>Crack Process</i> (for percussion, trumpet, electric guitar, and computers with real-time processing and motion tracking).</p>	<p>Intel Core 2 Duo computers released (7,100 MIPS).</p> <p>Apple switches its computers to Intel processors, and includes support for multiple</p>	<p>Centro Mexicano para la Música y Artes Sonoras (CMMAS) established in Morelia, Mexico.</p> <p>Adaptive computer game audio techniques become</p>

	<p>Gerard Pape composes <i>Héliophonie I</i> (for eight-track tape and video).</p> <p>Kaija Saariaho composes <i>Tag des Jahrs</i> (for mixed choir and electronics).</p>	<p>operating systems (Mac OS X, Windows and virtualization).</p> <p>Nintendo releases Wii gaming console with Wii Remote, which becomes popular with many sensor-interface constructors, offering an inexpensive wireless computer sensor interface.</p>	<p>common with the release of <i>Lara Croft: Tomb Raider Legend</i> computer game.</p> <p>The Game of Life Foundation (Netherlands) develops a 192-speaker sound system, the first portable Wave Field Synthesis system, exclusively for the presentation of electronic music.</p>
2007	<p>Cort Lippe composes <i>Music for Snare Drum and Computer</i> (for Snare Drum and live DSP).</p> <p>Agostino Di Scipio composes <i>Modes of interference n.3</i> (installation with 3+ e-guitars, 3+ combo amps &amp; computer).</p>	<p>Apple iPhone released, providing a consumer multi-touch interface device.</p> <p>Mac OS X 10.5 released.</p> <p>Microsoft introduces the Microsoft Surface, a functional multi-touch table-top computer.</p> <p>Windows Vista released.</p>	<p>Apple release Logic 8, DAW software, capable of handling 255 audio tracks without additional DSP hardware.</p> <p>Cercle pour la Libération du Son et de l'Image (CLSI, a laptop orchestra) is formed in Paris.</p> <p>Waseda University achieves a natural-sounding, flute playing anthropomorphic robot, with vibrato.</p>
2008	<p>Cort Lippe composes <i>Music for Tuba and Computer</i>, premiered January 2009 at ZKM, Karlsruhe Germany.</p> <p>Gerard Pape composes <i>Héliophonie II</i> (for eight computers and video).</p> <p>Carla Scaletti composes <i>SlipStick</i> (for Continuum fingerboard and Kyma) running on the Pacarana.</p>	<p>Large Hadron Collider (LHC) is completed by the European Organization for Nuclear Research (CERN).</p> <p>Multi-core computers are common with 3+ GHz Intel Xenon processors, such as Apple's Mac Pro (50,000+ MIPS).</p> <p>RjDj released, allowing the execution of Pure Data patches on the iPhone.</p> <p>Spotify is launched as an internet streaming music service in Sweden by Spotify AB, to provide rights-managed music streaming for record companies.</p> <p>TouchOSC released for the iPhone, allowing the simple implementation of custom graphical touch control systems.</p>	<p>DAW software is very common, sometimes a commodity, as are plug-ins for DSP effects and synthesis.</p> <p>Downloaded music tops the Billboard Magazine's Classical Chart after it decides to allow download-only music.</p> <p>Keith McMillen Instruments releases the K-Bow sensor mechanism for a string player's bow and StringPort string-to-USB 2 controller interface for guitar players, making sensor control of synthesis more commercial and feasible for standard musicians.</p> <p>Max/MSP 5 released with a greatly improved user interface.</p> <p>Stanford Laptop Orchestra founded.</p>

2009	<p>Rand Steiger premieres <i>Cryosphere</i> (for orchestra and electronics - live processing using Pd) at Zankel (Carnegie) Hall, New York.</p>	<p>Computing hardware continues to break previous performance limitations, mostly by running more CPU cores in parallel.</p> <p>Downloaded music accounts for 35% of all music sales, CDs making up the other 65%.</p> <p>Mac OS X 10.6 released.</p> <p>Windows 7 released.</p>	<p>At least 1,000 computer music studios exist in universities and institutions around the world, many engaged in research. Since most personal studios are also computer music studios, there are hundreds of thousands to millions, worldwide.</p> <p>AudioMulch 2 released (for Mac and PC).</p> <p>Max for Live released bring the DSP and patching capabilities of Max/MSP to the popular Ableton Live music production environment.</p> <p>Symbolic Sound release significantly updated hardware, Pacarana, for the graphical Kyma X synthesis system.</p>
2010		<p>Apple iPad released, providing a larger multi-touch interface device at consumer prices.</p> <p>Downloaded music accounts for 50.7% of music sold in the USA, with physical CD sales accounting for 49.3%.</p>	
2011		<p>Mac OS X 10.7 released, merging parts of iOS into more mainstream computing.</p> <p>Napster finally closes through a merger with Rhapsody.</p>	<p>Csound for (Ableton) Live released.</p> <p>Fairlight CMI iPhone &amp; iPad app is released, including the complete CMI sound library and an accurate representation of the Page R sequencer.</p>
2012		<p>Higg's boson-like particle (a theorised sub-atomic particle) is first claimed to be found at the LHC, along with other new particles.</p>	<p>Fairlight CMI-30A (30th anniversary) is released, a "retro" re-release of the original Fairlight CMI, with the same look and feel but with updated internal hardware.</p> <p>Keith McMillen Instruments releases the QuNeo touch controller with OSC support.</p>

2013		<p>Higg's boson is confirmed to be observed at the LHC.</p> <p>It is reported late in 2013 that online digital music sales decrease 5.7 percent (Nielsen SoundScan and Billboard) for the first time, due to more users choosing to listen to music via online streaming services such as Spotify.</p>	
2014			

**Notes:**

1. The second column of the list above reflects a (sometimes personal) collection of music that are pieces made (mostly) with the use of a computer, or significant other works (usually including electronics) often of interest to computer music practitioners. It is not a particular filtering or censorship of the available music, the list is limited as there is far too much to include. While some of the pieces may appear to be instrumental in nature, these have (mostly) been composed with algorithmic techniques using computers.

The completeness and inclusiveness of a list such as this is always an issue. While every attempt has been made to make this as inclusive, complete and accurate as possible, there will inevitably be omissions that someone thinks are significant, if for no other reason than a complete list would fill a volume. While it is hoped that all of the significant and important events have been included, any omissions are unfortunate and possibly due to a lack of available documentation, and not the lack of research effort or an attempt at filtering or censorship. ([top](#))

2. Steel band and wire recorders had existed for some time already and German engineers had developed a coated plastic tape for magnetic recording, but it was not very high quality. Although high-frequency AC bias was known of (with patents in the USA, Japan and the UK) and applied to wire recorders, it was in 1941 that the use of high-frequency bias was accidentally discovered by the Germans which gave a dramatic improvement in the quality of magnetic tape recording. The Allies during WWII were surprised by the length of German broadcasts, which sounded as if they were live, as they did not know about the high quality of the new magnetic tape recorders. This technology spread after the war. ([top](#))

3. MIPS (Millions of Instructions Per Second) is a measure of the raw computing power of the CPU (Central Processing Unit) of a computer, an indication of how many instructions it can perform in a given time. MIPS is generally regarded as being a very poor measure of computing power (sometimes jokingly called Meaningless Instructions Per Second), as it does not take into account other important factors such as the instruction mix (some instructions take more time than others) and data input and output capabilities. However, for the simplistic use here of giving some indication of the changes in raw computing power over time, it is adequate. There was also a microprocessor manufacturer named MIPS Technologies. ([top](#))

4. CSIRAC played music at least several months before the Ferranti Mark I, and possibly much earlier. Unfortunately, there is no other surviving evidence about the Ferranti music, apart from the BBC recording.

There are various brief, anecdotal, reports of computers playing music in a range of ways at about the same time as CSIRAC. These include an assortment of sound producing mechanisms, incorporating; attaching a speaker to a serial buss or part of the computer, placing radio equipment near the computer and playing sounds through the radio's speaker via radio frequency interference (now part of 'hardware hacking' practice), and programming computers to print on large, electro-mechanical, printing machines such that the rapid printing created tones, among other methods. Unfortunately, there are no surviving recordings of these activities, and so far there is no surviving evidence from the time.

It is important to note that these early attempts at making computers play music did not use a digital-to-analog converter (DAC), or pre-determined synthesis waveforms. The developments initiated by Max Mathews and John Pierce have the distinction of being the first musical use of a DAC, as well as going beyond what was previously the playback of standard or popular melodies, to investigating the very rich musical possibilities offered by the computer. Thus it is Mathews and Pierce, whose work led to the great musical consequences and advances of computer music, who are the rightful fathers of the genre. ([top](#))

**References:**

Chadabe, Joel. 1997. [Electric Sound](#): The Past and Promise of Electronic Music. Prentice Hall, Upper Saddle River, New Jersey.

Collins, Nick., and Julio d'Escriván. 2007. [The Cambridge Companion to Electronic Music](#). Cambridge University Press, Cambridge: pp xiv-xxi.

Manning, Peter. 2004. [Electronic and Computer Music](#). Oxford University Press, Oxford.

Roads, Curtis. 1996. [The Computer Music Tutorial](#). MIT Press Cambridge, MA, USA.

De Montfort University, ElectroAcoustic Resource Site, <http://www.ears.dmu.ac.uk/spip.php>

The EMF Institute, The EMF Institute Big Timeline, <http://emfinstitute.emf.org/bigtimelines/bigtimeline.html>

120 Years of Electronic Music, <http://120years.net/nav.html> - now only available from the Internet Archive [here](#).

Much information is also available in the following journals:

[Computer Music Journal](#)

[Leonardo](#)

[Leonardo Music Journal](#)

[Organised Sound](#)

There are snippets of information in on-line forums, websites and community mailing lists, such as the [International Computer Music Association](#), [CEC-Conference](#), [Electronic Music Foundation](#), [Australasian Computer Music Association](#) and so on. ([top](#))

### **Acknowledgements:**

Many colleagues and friends have assisted in this chronology, they include; Christopher Ariza, Kevin Austin, Clarence Barlow, Natasha Barrett, Richard Barrett, Paul Berg, Andrew Brown, Phil Burk, Max Burnet, Warren Burt, Nicolas Collins, Perry Cook, Roger Dannenberg, Nick Didkovsky, Richard Dudas, Tom Erbe, Karlheinz Essl, Ricardo Dal Farra, Kelly Fitz, Adrian Freed, Christian Haines, James Harley, Pär Johansson, Sukandar Kartadinata, Paul Lansky, alcides lanza, Andrés Lewin-Richter, Mats Lindström, Cort Lippe, James A. Moorer, Ake Parmerud, Joao Pedro Paiva de Oliveira, Jean Piché, Larry Polansky, Miller Puckette, Tom Rhea, Curtis Roads, Jo Scherpenisse, Andrew Sorensen, Ken Steiglitz, Kees Tazelaar, Peter Thorne, Matthew Wright, David Zicarelli, and also the editor of [The Oxford Handbook of Computer Music](#); Roger Dean - my gratitude and many thanks to everyone for helping to make this as complete and accurate as possible. ([top](#))

### **Usage:**

The information on this page may be used for any educational or personal purposes whatsoever. Acknowledgement is appreciated. No commercial use is allowed without prior written permission (contact email is at the top of the page). ([top](#))