# Brief History of Electronic and Computer Musical Instruments

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## 1 Theremin: the birth of electronic music

It is impossible to speak of electronic music and not speak of Theremin (remember that high-pitch melody sound sound in Good Vibrations ?) Theremin was the instrument that has started it all. Invented remarkably early - around 1917 - in Russia by Leon Termen (or Theremin, spelling varies) it was the first practical (and portable) electronic music instrument, and also the one that brought the electronic sound to the masses (see [27]). It was preceded by Thelarmonium, a multi-ton monstrocity that never really get a lot of attention (although technically very innovative, see [25]), and some other instruments that fell into obscurity. On the other hand, Leon Theremin got popular well beyond the Soviet Union (where even Lenin got to play his instrument once!). He became a star in the US and taught a generation of Theremin players, Clara Rockmore being the most famous one. In fact, RCA even manufactured Theremins under Leon's design in 1929 ( [27])!.

So what was this instrument ? It was a box with two antennas that produced continuous, high-pitch sounds. The performer would approach the instrument and wave hands around the antennas to play it. The distance to the right (vertical) antenna would change the pitch, while the distance to the left (horizontal) antenna would change the volume of the sound (see [2], [3] for more technical details). The Theremin is difficult to play, since, like on violin, the notes and the volume are not quantized (the change in pitch is continuous). Moreover, there are no strings, no frets, no keys, and even something done more easily on "traditional" instruments - playing a scale - is quite hard.

It is hard to overestimate the importance of Theremin. First of all, it was one of the first instruments that produced sounds entirely electronically. Secondly, playing the instrument is differs

Figure 1: Leon Theremin and his Instrument [1]

entirely from playing any other instrument:no physical contact is required to play it. The process of playing Theremin is akin to producing the sound from 'nowhere' by waving one's hands !(hence another original name for the instrument, 'Aethervox', "the voice from ether"). Now Theremin-like optical controls are common on synthesizers. Also, the inventor of the first widely used commercial synthesizer, Robert Moog, started his career in electronic music by making Theremins, which have fascinated him all his life. In fact, in his late years he turned back to making high-class Theremins, until death in 2005 (as described in [4])

Yet another way in which Theremin advanced the music scene is that some serious classical composers (like Shostakovich !)composed for the Theremin. An instrument is worth nothing if there is no music for it, and there was a supply of both composers and performers for Theremin, thus creating a big interest in novel music technologies at the time. Unfortunately, Theremin was to be nearly forgotten; the main reason for that being the mysterious disappearance of Leon Theremin, the inventor and the main Theremin showman (see [27]).

Figure 2: Leon Theremin and his Instrument, in the US

See also [5] and [27] for more information about the mysterious life of the inventor and his invention (Leon Theremin was be kidnapped by KGB (or deported by CIA) to serve for the USSR intelligence; he was thrown into jail, but was later freed, engineered espionage devices and lived a long life, while the West thought he was dead. Finally 'discovered' around the Perestroika period, he told the details of his life story).

## 2 The magnetophone

The further development of music as we know it would be impossible if German engineers did not develop a reliable, hi-fidelity tape recording technique during World War II, which resulted in what is know as the Magnetophone (see [6]).

After the war, this technique became available worldwide, allowing the artists much more freedom of musical expression in their studio recordings. The main difference is that the sounds recorded on tape (unlike the ones recorded on a phonograph cylinder or a vinyl disc) can be mixed without losses, so the different parts of a song can be recorded separately.

Figure 3: AEG Magnetphone

## 3 The music scene of the 1950's

At this time, a lot of avant-garde composers start experimenting with the new medium. Even before war, composers tried to break out of the classical paradigm by using sounds that do not come from traditional instruments. Now, they record the sounds of nature or mundane objects (toys, trains, etc.) on a tape, and use various "non-musical" sounds to create music - which is now called Music Concrete, invented by Pierre Schaeffer ( [7]). John Cage explores noise and silence ( [8]). Karlheinz Stockhausen plays with noise, modulators, oscillators and other electronic components, as well as real-world sound to create his revolutionary works ( [25]). The musicians are ready for the synthesizer.

It is important to understand that the synthesizer did not just appear out of nowhere. For a synthesizer to appear, there should have been an interest in experimental music, together with composers willing to use the new technology. This is indeed what was happening before the synthesizer appeared, making it a technological and commercial success.

## 4 The synthesizer

Although scientists experimented with electrical components that made sounds for quite some time by the mid-sixties, and there was work done with sound filters and other electronic components, all those technological marvels were out of reach of most musicians. All this changed in the late sixties, at around the same time, Don Buchla and Robert Moog delivered their synthesizers on the market (see [9]).

Figure 4: Buchla 200. We have it at Stony Brook!

These were huge modular systems which one would use to produce sound by connecting various components with patch cords, in the style of the early telephone stations. The main components are:

- Oscillators. These generate a waveform. A simple oscillator would generate a sine wave with a set frequency. More advanced oscillators would generate triangle waves, rich square waves, or morph continuously from sine to square. You should think of a square wave as a superposition of infinitely many sine waves.
- Filters. These filter out high or low frequencies.
- ADSR (also known as Envelope Generators; read: Attack-Decay-Sustain-Release) would generate curves of voltage to modulate pitch or amplitude
- LFO (Low Frequency Oscillator) would be used to modulate filter or amplitude, but, as all other components, can be linked to anything
- Control pad or keyboard

Figure 5: The Famous Moog Modular system

- Sequencer to store set of pitches/volumes/lengths to be played back
- etc. (see more on [10], [11] on these machines; read [30] for a definitive guide to synthesizer modeling)

It is really hard to describe the variety of sounds that can be produced with a modular system. Only going to an electronic music studio and playing with one, or downloading a software modular system emulator will give you the impression (take a look at Moog Modular V, the software emulation of the Moog Modular endorsed by Moog himself; or try the freeware Minimogue VA to get some notion of what an analog synthesizer might feel like)

Unlike the (eerie) sounds produced by Theremin, or the sounds of Music Concrete, the sounds of the early synthesizers were more pleasing (or could be more pleasing, if the user so desired), and at the same time, they were novel, unusual and fun. Wendy Carlos re-recorded Bach's music on Moog's synthesizer, to be released under the title Switched-On Bach (a.k.a S-OB, see [12]), - and this album went platinum (the first ever classical platinum ever to go platinum!)

The synthesizer brought electronic music from experimental to the mainstream stage. The arrangements of classical pieces for a synthesizer were something that both the old and the new generation would listen to. Synthesized sound has appeared in movies and popular music, and the electronic sound has reached the ears of the majority of the population. Every musician wanted to get his or her hands on a synthesizer (or should have wanted!), and the music industry immediately gained new players, such as ARP, Sequential Circuits, Yamaha, Roland etc. However, the age of analogue equipment would be over soon, as it was being replaced by digital machines and computers.

## 5 Fairlight CMI

Fairlifgt CMI (by Fairlight, [13]) was an ambitious (and successful!) project that started the era of computer music and heavily influenced the hardware scene. CMI in it stands for Computer Music Instrument, and a computer it is !

Figure 6: The influential Fairlight CMI

Coming from the land of Australia (1980-1982), the synthesizer/computer system featured enough innovations to write a small book about. It was a basically a computer with a keyboard connected to it, featuring a screen (with a lightpen!) and GUI for sound editing and sequencing. Pattern-based digital sequencing was one of the big innovations of Fairlight.

Sequencing means being able to record and manipulate patterns, and then play them back in certain order, overlaying and mixing them. By recording I mean storing the electrical signal or data that used to produce the sound, not the sound itself. This was one technology that was available only on a very crude level with analog machines. Each note corresponded to a small box with several knobs to adjust the sound, and recording length was limited by the number of boxes. On the other hand, digital sequencing is only limited by the amount of main memory (and even then, parts can be backed up). Only one single digital interface is needed to edit the sequences once they are recorded.

Of course, one could record electric signals on a tape before the digital era has started. However, if one note in a chord is played wrong, it is nearly impossible to fix if it were recorded in the analog format. Correcting a mistake in a sequenced song is similar to correcting a note in a musical score (which, in fact, it really is). This enables a composer to produce music without having to perform it: the sequences are entered into the computer, which can play them back at a touch of a button.

Probably, the technology closest to sequencing was the piano roll (which is fed into player pianos). It is a paper tape with punches corresponding to key presses. However, "editing" punched paper is not something that could be done at all; whereas editing sequences on a system like Fairlight CMI could be done efficiently.

The GUI (Graphical User Interface) of Fairlight was a significant innovation by itself, and introduced the concept of a digital workstation, where a keyboard is connected to a computer for playing and recording for complete production cycle.

However, the main novelty of Fairlight was the introduction of (digital) Sampling. The Fairlight could record any real-world sound into its sound card memory, and use that as the basic waveform for sound creation (instead of sines and square waves on the classic analog synthesizers). One could record the sound of trumpet, and play trumpet on Fairlight; or one could use human voice, nature noises, any instrument, or anything that makes sound in musical compositions instantly ! Fairlight could sound like anything; complete score for a movie could be made on Fairlight CMI, as, in fact, was done by Keith Emerson, one of the most prominent keyboardists and and an electronic music pioneer ( [14]. See [15] for a more technical description of the instrument.

It is important to understand how the synthesizers have changed when going from analog (like Moog) to digital (Fairlight CMI). New possibilities were opened (Sampling, Sequencing and Digital Synthesis) that were not even possible with analog machinery. On the professional level, these two techniques form the basis of how the majority of music is done today. The sequencers have become easier to use, and the samplers can be larger; modern computers can run more complicated algorithms to generate sound - but the basic principles and the workflow has not changed critically. Invention of a digital workstation allows one composer to create complete orchestral works, without the need to hire an actual orchestra ! The digital techniques have effectively replaced the analog machinery: after all, the analog synthesis can be performed digitally, or the sound of the synthesizer can be sampled; thus one does not need a room full of synthesizers, but a box of samples. (Although real analog sound is much nicer and more "alive" than the sampled one, the analog machines are quite expensive, much more so compared to sound samples or emulators in software).

# 6 MIDI

Probably the most important music technology that has influenced all music equipment and has been left unchanged since the 1980's is MIDI, introduced in 1983, which stands for Musical Instruments Digital Interface ( [28]). MIDI for electronic music is what TCP/IP is for the Internet; both of these technologies came from the same year and both have changed the world. Basically, MIDI protocol allows the musical instruments to talk to each other (more on that later) and record music data in a standard way. Before MIDI was introduced, each synthesizer or system used it own way to record or transmit music data. For instance, Fairlight CMI keyboard could only be connected to the Fairlight CMI computer, for there were no standard about what signal should be sent. Furthermore, Fairlight sequencer could only control Fairlight synthesizer, and other sequencer stations had to be used only with the equipment from the corresponding manufacturer. As a consequence, nearly all synthesizers came with built-in keyboards (or, as the size of the electronics shrunk, the synthesizers were built into keyboards). Keyboardists in rock and pop bands would often be hidden behind the "wall" of synthesizers, if they wanted to use more than one sound or layer together the sounds from several synthesizers.

All this changed when MIDI was introduced. On a basic level, MIDI can be thought of as sheet music for synthesizers or computers, with specifications on how to transfer it. Another way is to view it as a command language: when the performer presses keys or twists knobs on a keyboard, a series of commands are sent to the sound modules that generate sounds according to the commands (we shall further call them MIDI messages). Each message also bears a timecode, so the messages can be recorded, processed, and then sent back to the sound module.

There are two most common MIDI messages: Note On and Note Off. When a performer presses a key on a keyboard, a Note On message is sent with the data about which key has been pressed and with what velocity. Typical sound module would receive this message and start playing that note, until it receives a Note Off message, which is sent when the performer releases that key.

Now the creators of MIDI specification (mainly, Dave Smith, who was the driving force and the original proposer of MIDI) have incorporated the ability to control several instruments from a single keyboard or sequencer. Each message carries a channel number, from 0 to 15, and each instrument can be set to listen to the messages on only one or all channels.

| TIMESTAMP | IN | PORT | STATUS | DATA1 | DATA2 | CHAN | NOTE | EVENT |
|---|---|---|---|---|---|---|---|---|
| 000076EA | 9 | 3 | 90 | 3C | 53 | 1 | C 4 | Note On |
| 000078A6 | 9 | 3 | 80 | 3C | 12 | 1 | C 4 | Note Off |
| 00007939 | 9 | 3 | 90 | 3E | 54 | 1 | D 4 | Note On |
| 00007A44 | 9 | 3 | 80 | 3E | 30 | 1 | D 4 | Note Off |
| 00007B09 | 9 | 3 | 90 | 3F | 21 | 1 | Eb 4 | Note On |
| 00007B93 | 9 | 3 | 80 | 3F | 40 | 1 | Eb 4 | Note Off |
| 00007D87 | 9 | 3 | 90 | 42 | 37 | 1 | F# 4 | Note On |
| 00007F88 | 9 | 3 | 80 | 42 | 01 | 1 | F# 4 | Note Off |
| 000083DD | 9 | 3 | 90 | 3E | 3C | 1 | D 4 | Note On |
| 0000855D | 9 | 3 | 80 | 3E | 05 | 1 | D 4 | Note Off |
| 00008622 | 9 | 3 | 90 | 42 | 44 | 1 | F# 4 | Note On |
| 0000873B | 9 | 3 | 80 | 42 | 08 | 1 | F# 4 | Note Off |
| 00008D48 | 9 | 3 | 90 | 3C | 56 | 1 | C 4 | Note On |
| 00008D48 | 9 | 3 | 90 | 3F | 32 | 1 | Eb 4 | Note On |
| 00008D52 | 9 | 3 | 90 | 37 | 2A | 1 | G 3 | Note On |
| 00008D9B | 9 | 3 | 80 | 3F | 18 | 1 | Eb 4 | Note Off |
| 00008DA1 | 9 | 3 | 80 | 37 | 12 | 1 | G 3 | Note Off |
| 00008DA5 | 9 | 3 | 80 | 3C | 3C | 1 | C 4 | Note Off |
| 00008DF2 | 9 | 3 | 90 | 3F | 43 | 1 | Eb 4 | Note On |
| 00008DF2 | 9 | 3 | 90 | 3C | 55 | 1 | C 4 | Note On |

Figure 7: A typical stream of MIDI messages

See [28] for detailed specifications on other kinds of MIDI messages, their structure, etc.

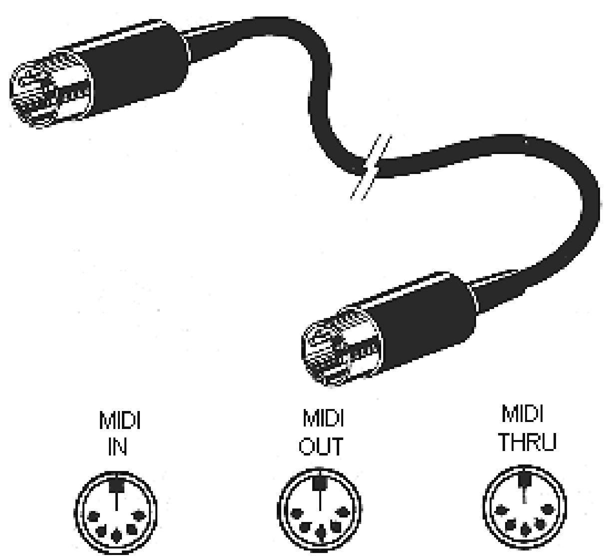


Figure 8: MIDI Cable

To link the keyboard (MIDI Controller) to the sound modules (samples, synthesizers, etc.) or sequencers, the standard MIDI cable was introduced. Each MIDI controller would have an OUT port, and sound modules would typically have IN, OUT and THRU ports, allowing MIDI devices to be linked in a "daisy chain" style. Now the rock keyboardists could go on a scene with a single keyboard, controlling a synthesizer rack in the back!

More importantly, MIDI created a universal way to interconnect musical instruments: sound modules, controllers and sequencers. Even older models could be retrofitted with a MIDI I/O module. Specifically, MIDI interfaces for the popular computer systems (Apple Macintosh, Commodore, etc.) were introduced immediately, allowing the general purpose computer to become the ultimate MIDI device. Now, with appropriate software, everyone could have a Fairlight ! Although computers were not powerful enough to completely replace hardware synthesizers, all the sequencing since MIDI is done on regular computers, using software. As computers grew more powerful, the synthesizers are more and more often implemented purely in software, even allowing high quality emulation of analog synthesizers. The hardware synthesizers are much less widespread now, but MIDI is everywhere, and most often it is used in its original form - 1.0 specification. See [16], [17] for further details.

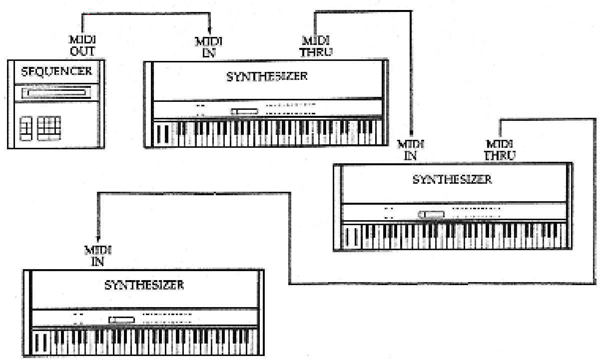


Figure 9: MIDI Daisy Chain

## 7 General MIDI, XG, KAR and other MIDI extensions

GM, or General MIDI was an extension of MIDI which specified what instrument numbers should correspond to (i.e. 1=Piano, 17=organ, etc.) This was done with the intention to allow musicians to interchange music in MIDI format, instead of sending/storing large waveform files. Consequently, most of the home computers and keyboards were released in adherence to the GM specification, and MIDI files started to be used in games, and later - web pages. Since the early soundcards did not come with a high-quality synthesizer or sampler built-in (all they were FM-based and low-quality, which is bad for imitating natural instruments), the general population got acquainted with MIDI through bad sound. A lot of people still think that MIDI "sound" is something bad, coming from an old computer or a cellphone (since cellphone ringtones are naturally stored as MIDI data). The truth is, obviously, that there is no such thing as "MIDI sound". One can't tell how good or bad the instrument sounds by looking at sheet music. Nowadays, General MIDI is all but abandoned, since the professional musicians were not really using it(every musician has his own unique set of gear, so MIDI data won't sound the same on other musicians' setups anyway). Yamaha came with its own standard, XG, which is similar to GM, but with more instruments. Karaoke machines "feed" on .kar files, which are MIDI files augmented with timed lyrics. All these extensions had nearly no influence on computer music, since they were not much used in the industry.

## 8 Digital Synthesizers and Yamaha DX-7

In 1983, one of the most famous digital synthesizers was released: YamahaDX-7 ( [18]). The synthesizer featured a new, revolutionary digital synthesis method, called FM synthesis (Frequency Modulation) . This method involved one oscillator modulating the frequency of another to produce a wide range of sounds that can be morphed easily with controls, have great dynamics and change with time. Most of the sounds from the 80's were made on FM synthesizers (Casio followed Yamaha with release of their similar Phase Distortion synthesizers, Roland released Juno).


Figure 10: Yamaha DX-7, the best-selling synth in the world

The principles of FM synthesizers are quite complicated, and you can read more about them at [19] (also see [29] for detailed descriptions of modern synthesis methods). One particular property with regards to implementing FM in hardware is that it is difficult to implement using analog components, but is easy implementable using digital techniques. In fact, while the on-board memory was expensive and scarce, FM synthesizers were cheaper to manufacture than sound modules based on sampling (or pre-recorded samples stored in ROM; these are called romplers). This was the primary reason why a small FM synthesizer was the music-making component of early sound cards, even for sounds that were supposed to represent real instruments.

The influence of the DX-7 and FM synthesis on the music scene of the 80's was huge. The machine was reasonably priced, it sounded fresh at that time, and everybody wanted to get it. However, it was very difficult to program, and a lot of of people ended up using factory preset sounds, or getting sounds that were similar; this is why a lot of music from the 80's has the same 'feel' to it. This contributed to the demise of the FM synthesizers in the 1990's. As ROM memory became cheaper and larger, wavetable synthesis based on samples from real instruments became the standard in all areas: on professional keyboards, home keyboards and computer sound boards. However, such method of synthesis does not allow as much of realtime sound manipulation and control and has limited dynamics; besides, it's more about modifying recorded sound that creating some completely new sound from scratch. As a result, we see a resurgence of software-based FM synthesizers, such as Sytrus, which offer a much wider range of sounds and a more flexible control than the hardware units ever presented. Software FM synthesizers nearly completely replaced their hardware counterparts because the original hardware was using the same digital methods, so the sound produced by software is authentic (which is not necessarily the case with analog synth emulation, where analog components add noise and individuality to a system).

## 9 Early soundcards

The very first sound board to be added to a IBM-PC compatible system was Adlib sound card (see [20]). It was basically a Yamaha YM3812 synthesizer chip interfaced with the PC ISA slot. Prior to that, the computer only had a single "beeper", a speaker that was mainly used for emitting beeps for system errors and provided and early form of "sound" in games. Now, the computer could play music ! Sierra started to support Adlib sound boards in its games, and it became popular. However, since Adlib was purchasing the widely available chip from Yamaha, Creative did the same thing and released a compatible Sound Blaster card and driving Adlib to obscurity. Creative Sound Blaster remains the leading sound board on the market up to this day (although it has been largely replaced with integrated sound chips). Sound Blaster also featured a Joystick port, and a DAC, allowing to play sounds, not just responding to MIDI messages.

MIDI was used for quite some time in video game music because it allowed to save space.

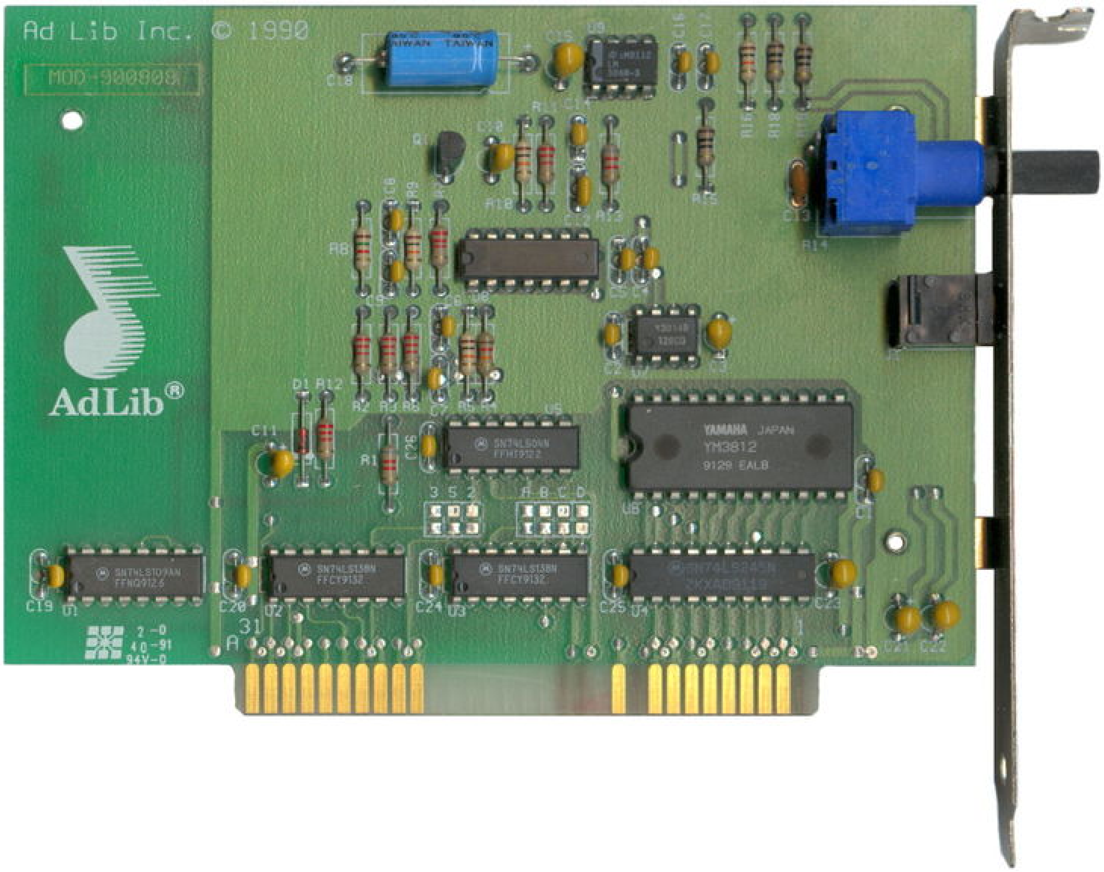


Figure 11: AdLib Soundcard: note the Yamaha chips

As more cards included wavetable synthesis, the MIDI soundtracks sounded nicer on those cards. However, identical performance could never be guaranteed with such scheme, so games stopped using MIDI eventually.

Nevertheless, even the most primitive sound cards had a huge influence on computer music, since this technology brought downscaled components of a professional studio into the homes of computer amateurs and gamers. Thus people that were not musicians have been exposed to new music technologies, and some started to play with it. As the soundcards developed, so did the software, and in the end a computer with a soundcard has become the electronic music studio.

## 10 Demoscene and tracking

MIDI was designed as a communication protocol, not as a music storage format. The obvious disadvantage of using it for music storage and transfer is that MIDI does not store the synthesizer it controls, nor does it contain the actual sound. Consequently, an alternative MOD format has appeared on computers as early as Commodore and Amiga that contained the samples along with the note data. This format was very widely used in videogames and demoscenes. The software to develop music in this format was called a Tracker, which featured sequencing schemes somewhat similar to the ones on Fairlight CMI. Trackers used the soundcard synthesizer, and consequently did not get much usage among professional musicians who used MIDI sequencing with their hardware. One of the modern professional reincarnations of tracking software is ReNoise ( [21]), with many freeware trackers also available, such as ModPlug tracker ( [22]) and many others.

You can listen to the classic tracked music re-sampled in high quality at [23].

Tracked music has seriously affected the video game music, and, as a consequence, a lot of musicians in their childhood. A lot of independent music on Newgrounds, for example, has been influenced by the music of this kind. The significance of tracked music was that for quite a long period of time this was the only way to make music on a computer system. Most of computer music that was to be listened to on a computer (i.e., in video games) was tracked. Tracking software also allowed people without formal musical education and money to buy expensive music equipment to compose real, beautiful music. Trackers were the precursors of modern loop-based professional music software.

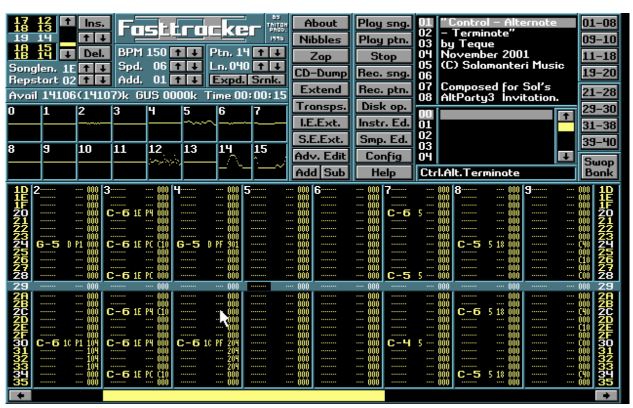


Figure 12: Fast Tracker 2, a typical tracker look

## 11 Sequencers and DAW's

As the computers became fast enough, and the hard drives became large enough, the personal computer became the complete DAW (Digital Audio Workstation), so that the musicians do not

Figure 13: Cubase SX3, modern sequencer and audio workstation

need to record the sound on a digital tape, and all production could be done on a computer. In fact, if music production does not involve recording live sound, all the hardware a musician needs is a laptop and a MIDI controller - the rest is done in software (MIDI recording and editing and sound generation). The software sequencer started to appear on a computer in about 1989 (Cubase), and since then have grown into applications that do all music-related tasks. See [26] for practical tutorials on how to compose with Cubase (using other systems is very similar).

The software audio workstations of today emerged naturally from hardware MIDI sequencers and workstations like Fairlight CMI. The only real difference is that instead of being run on specialized hardware, these programs can be run on a regular home computer, which means flexible graphical interface and low cost.

## 12 VST Instruments

As the time goes on, and computers become even more powerful, it becomes possible to emulated complicated electronic (and even non-electronic) instruments on a regular computer. Most of the synthesizers today are implemented in software. Consequently, Steinberg has developed a standard to interconnect software synthesizers, effects and sequencers, eliminating the need for virtual MIDI cable. This new technology is called VST (Virtual Studio Technology); see [24] for details and corporate history. Although VST is not the only technology (Apple is competing with AudioUnit, for example), it is the most widespread one, and there are thousands of commercial and free synthesizers and effects available in this format.

VST marked the beginning of the new era, where software-based synthesizers are to be taken seriously and are the mainstream technology. Before VST, software synthesizers were mainly used to produce sound samples or experimental music.


Figure 14: The front panel of Superwave P8,a free VST synth

## 13 MIDI Controllers

As laptops are becoming the machine of choice for musicians, we begin to see how the growth of the market of compact MIDI keyboard controllers (usually, 2 octaves). Also, the increasing interest in synthesizers and real-time sound manipulation has a corresponding effect on keyboard MIDI controllers, which these days nearly all come with knobs and sliders. Of course, specialized control boards with sliders and knobs were always available, but since the sound modules of the 90's were mainly wavetable synths or samplers, most of the musicians did not have a need for knobs. Most of the MIDI controllers are designed to be connected to a computer directly via USB interface, transferring MIDI messages over USB (although standard MIDI jacks are still present). Finally, the ultra-slim MIDI controllers have appeared on the market, making it possible to fit a complete studio into a relatively slim backpack.

Many other types of MIDI controllers are available: pads, slide surfaces, accordeons, breath controllers, etc. It is possible to interact with software in various new ways : any MIDI message can be assigned to any action in Ableton Live, for example, making interaction between the human

Figure 15: Behringer UMA25s, a slim compact MIDI controller

and software unbounded.

## 14 Beyond Hardware

As hardware becomes cheaper and more accessible, many self-contained hardware/software systems have appeared on the market. Some of the famous ones are Yamaha Tenori-On, Korg Kaossilator, and Reactble , each featuring a unique way to interact with the synthesizer. For example, Reactable is a backlit table on which the performers place marked plastic objects, the Tangibles, to create and control a synthesizer system in real time (see Figure 16).

Figure 16: Reactble with many Tangibles on it

There is no excuse today not to play with the synthesizers - so go out and explore!

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