Gaute Barlindhaug

Analog Sound in the Age of Digital Tools: The Story of the Failure of Digital Technology

An important issue in the studies of new media has always been to explore and explain the relationship between technological evolution and cultural change. In this regard, digital technology has often been viewed as the single most important tool in the creation of many of today's new cultural expressions. In media relying heavily on computer technology, like blogs and MMORPGs the case is obvious, but digital technologies can also be linked to changes in more traditional medias like film, music and even literature. Many understand the emergence of these novel expressions as a result of new technology overcoming the limitations of earlier analog media. Following this argument, one would expect that producing innovative documents in a new millennium would be the result of a digital revolution that had rendered earlier analog tools absolute. Today's society has in general a positive attitude towards the introduction of digital technology, seeing it as an improvement on its analog predecessors. In this article I want to take a closer look at these assumptions by making a detailed investigation into the role of digital tools in the production of popular music, hoping to say something more specific about the relationship between technological innovation and cultural expressions.

From a certain point of view, it clearly looks like digital production tools are the dominating force in the western cultural expressions of today. The 80s and 90s produced a large range of digital hardware, culminating in a growing software and computer industry. Through the application of software, computers can be turned into powerful tools for the production of documents. Most literature describes the introduction and development of digital media as providing great freedom in manipulating information, both for consumers and producers. For most of us, "digital" equals "new and better". To a certain degree this is also true of musical production. Diverse software has been designed to make computers function as tools for both recording and producing sound. One important trend in this regard is the integration of a range of so-called software synthesizers into your music production. These are programs that function like real-life machines, but existing only in the software environment of the computer. A good example of this is "Reason", made by the Swedish company Propellerheads Software, a sound production tool with the graphic and functional appearance of a physical rack. Here the user can add units like drum machines, mixers and synthesizers, and on the backside of the

rack you can connect the units together using colorful cables (fig1). Everything is very lifelike, but at the same time remains extremely virtual. “Reason” is exceptional in that it is a complete production environment, while most of the software synthesizers are made to function as a part of larger programs as plug-ins. These plug-ins are often simulating devices that also exist as hardware. At first this might seem like a prime example of the innovative development of digital media technology. But some aspects simply do not add up that easily. First of all: Why do we want software that functions like a real machine? After all, making word-processing software work exactly like a typewriter would not seem very novel. However, this is very much the case in music production. Secondly: With the plethora of software available, why are people willing to spend 1400 US$ on e-bay for a small battery-driven musical gadget from 1982, when you can get a software version for free? Academics have constructed a series of theories describing the impact of digital media, but how useful are these when trying to explain what is happening in a specialized field like music production?

Figure 1

It has always been the case that older technological elements are taken up by digital media. In the 1970s and 1980s, analog elements were deliberately exploited as metaphors in the development of graphic user interphaces the idea was to use elements from traditional office work to construct a computer system that would be easy to understand for the workers not specialized in using computers. In the late 1990s, Bolter and Grusin published their theory of remediation, describing and explaining the relationship between digital media and its older counterparts. Inspired by McLuhan’s claim that the contents of a media is another media, Bolter and Grusin focused on remediation as a process in which older technologies are absorbed into new digital media. In most of their examples the relationship between digital and analog media is one of competition, where the newer digital media tries to replace older technologies by appearing as an improvement. While a typewriter might be an important metaphor in understanding many word-processing software, the typewriter in its traditional form has been rendered obso-

lete by the software. Similarly, there doesn't seem to be any apparent reason to read a traditional newspaper when you can get the same information on the Internet. This remediation can also be seen as part of a "horseless carriage" phase of technologies, where we don't comprehend the novelty of inventions but instead relate them to more familiar media.

In music production, the relationship between new and old media is of a different kind. Software exists alongside its older analog counterparts, in a relationship much more complex than that of the metaphors and remediations we find in consumer media. These evolutionary contradictions in contemporary electronic music production are to a great extent a result of technology's role in musical aesthetics. This is an aesthetic dimension that makes it hard to use traditional academic theories to understand the relationship between music and the different technological media. To make a thorough investigation into the relationship between analog and digital tools, it is therefore important to view this relationship in relation to cultural expression.

By tracing the developments that created the premises for today's software synthesizers, I hope to achieve a wider understanding of the relationship between technological development and cultural expression, and in doing so reveal some shortcomings in established media theories. By way of example I will mostly focus on Propellerhead's "Reason" software, and try to explain its features in relation to cultural practice in musical production. The reason for focusing on electronic music is that it is a cultural form closely linked to the development of technology. Most of our understanding of digital innovations in our culture is derived from research into visual media, so by focusing on sound and music I hope to uncover some new relations. Furthermore, popular electronic music is from time to time used as an example to describe phenomena in contemporary technological culture. As I will show, sampling, a term from musical production, has also played a role in developing theories for other cultural fields, such as literature. In spite of this, the field of musical production has rarely been the subject of any thorough investigation outside the academic field of popular music studies.

Technology: tools or communicator

When trying to view electronic music in light of traditional media theories, it is crucial to point out that there is a tremendous difference in how academics and musicians perceive media technology. This difference also explains why media theories cannot explain what is going on in music production. Traditionally, academics think of media as something transmitting a message or functioning as the material basis for this message. There is a consensus that this material basis imposes constraints and influences what is communicated, and in that way affects

the result. However, in connection with electronic music, the media is constituted by a longer production chain which goes far beyond the immediate material basis. Even if the material basis for the music is the same, what ultimately defines its aesthetics is what media was used in its prior production. In musical expression, technology plays a crucial role as a tool for production, and not only as a means for storage and distribution. It is also important to point out that much of the technology used in music production contains media that easily can be perceived both as storage and producer of content.

Because of musicians' focus on tools, the division between analog and digital technology is for the musician not about technical evolution, but rather a question of aesthetics. The evolution of cultural ideas and aesthetics are in these cases a result of the use of the technology, not only of its technological evolution. According to this, the material aspect of technology becomes an independent entity whose importance is not based solely upon its relative novelty. For fear of being seen as technological determinists, I think many academics have neglected these aspects of media technology. When put to closer scrutiny, the implementation of digital technology can therefore turn out to have quite a different effect than originally thought.

The importance of aesthetic property in media's material aspects is one of the reasons why the theory of remediation does not always comply to musical production. In media science this remediation is often explained in relation to the media's desire to achieve transparency, to effectively transmit a message. According to this view, the reproduction of older medial forms in digital media is motivated by the desire to render the digital media transparent. If we see media as a material vessel to store and transmit a message, the concept of transparency has a crucial role in the evaluation of media technology. Some forms of music might have similar concepts of transmitting something "authentic", like the sound of an acoustic guitar, and in these cases technology can often be seen as an obstruction in the communication of music. Gilbert and Pearson use the term "index of visibility" to describe this musical equivalent to transparency (Gilbert and Pearson 1999, 122). It is important to point out that Bolter and Grusin also talk of transparency in music, but they relate it to "liveness", the actual performance of music, and not anything to do with the tools used in the performance (1999, 42). The difference lies in the fact that Bolter and Grusin sees the live band as the source of music, whereas according to Gilbert and Pearson's "index of visibility", the band and its instruments could (in certain cases) be understood as an obstruction to perceiving the artistic ideas. This concept was very much a part of the 1960s folk music movement, where electric instruments were banned, but Gilbert and Pearson argue that in contemporary music this hierarchy has been broken down. Musicians do not look for transparency, but the rater looks for a media with a distinct mark, the actual mediation that can be incorporated into a new aesthetic expression.

Bolter and Grusin are also very much aware that media is not always used to achieve transparency, but is also used to create specific mediations (1999, 35). The problem is that their account of this is rather limited. In general they describe it as a fascination with media, without explaining what exactly is so fascinating about it. By example, they mainly focus on multiple remediations of different media into one media, like medieval altarpieces or in avant-garde and pop art collages.

The aesthetics of recording

The introduction and use of recording technology is a suitable starting point to illustrate how musicians understand technological media as a tool, and to explain the aesthetic difference between digital and analog technology. This is an example of a media that functions for both storage and production. In most media and documentation science the introduction of recording technologies is understood as enabling the fixation of sound in time, meaning you can record a segment of sound, share it with others and replay it at any time you want. This effect corresponds to that of the introduction of writing in relation to speech. When digital recording was introduced, the possibilities for authentic reproduction and effective distribution of sound were increased. Whereas analog recording had a destructive reproduction process, digital technology enabled the infinite cloning of sound.

However, if we turn to musicians and look at how they view recording technologies, the picture becomes a little different. Already in the late 1960s, multitrack recording studios were used to create music that was impossible to play live, in that way creating a work of art that did not exist prior to the recording process (Frith 2004, 115). A long range of artists, including musicians as diverse as Glenn Gold and Miles Davis, has used recording technologies to revolutionize the concept of music production. This is a concept that even Bolter and Grusin have noted (1999, 42). Brian Eno describes the introduction of multitrack recording as: "Now this is a significant step, I think; it's the first time it was acknowledged that the performance isn't the finished item, and that the work can be added in the control room or in the studio itself" (2004, 128). It is easy to understand how recording technology played an important part in the evolution of new types of instrumentations and arrangements, but my point is that through this creative process, not only was the performative role of the musician changed; the recording equipment used also defined what popular music was to sound like. By focusing on the recording as a creative tool, rather than just a container for a musical performance, the realisation emerges that different tools create different sonic experiences.

Because of the great technological difference between digital and analog recording, there is also a great difference in their sound characteristics. This plays an im-

portant part in the final artistic result. An analog signal is an electric wave that corresponds to a sound wave. When storing it on a magnetic tape you have to take into account the tape hiss, the background noise created by the magnetic particles on the tape. When you record to tape, you therefore have to record at a loud a level as possible to reduce the overall hiss. In this process you are likely to slightly overload the tape, meaning you record a bit louder than the tape can take. This results in a slight dynamic compression, making the sound more compact and generating a soft distortion, often characterized as a "warm" sound. With the introduction of digital technology, the possibilities for editing and combining recordings are greater than with analog tools. However it also introduced a different sound. When you record digitally, you have an analog-digital converter that samples the sound wave at a specific rate and bit depth. By reversing the process and recreating the waveform from the sampled points, the sound can be replayed (Mitchell and McCullough 1995, 60). If the sample rate and bit depth is sufficient, this sampling technique can digitally record and reproduce realistic sounds without any distortion and very little background noise. But these aspects**,** which are often described as the advantages of digital recording, have turned out to be a problem. During the sixties and seventies, the soft distorted, and compact sound of analog recording, had during the sixties and seventies defined how a recording should sound. Not only had recording technology enabled instrumentation and arrangement techniques that surpassed that of earlier live performance, it had also, as a by-product, defined popular music soundwise. When digital equipment was released in the early 80s, although it opened many new creative possibilities in regard to arrangements and instrumentation, its neutral and realistic sound did not have the sonic qualities associated with music production (Warner 2003, 21). It was easy to use but there was a reluctance towards it in the industry because of its lack of these sonic qualities. Even today most musicians and music producers, though they use digital recording, prefer the sound of analog recording technology and invariably employ strategies to achieve this sound quality.

The sound of yesterday today

The difference in sound between digital and analog technologies is not only evident in recording, but also in sound production tools like synthesizers. With analog recording technology, the aesthetics had become embedded in the culture through many years of use. But with analog synthesizers, the most profound aesthetic and cultural effect did not occur until after the digital technology had taken over the market. In this sense, the emergence of analog synth aesthetics is also the story of the conflict between commercial technological evolution and cultural practice. To understand the productional context of digital tools today, it is important to look into the events of this first technological counterrevolution.

This evolution of analog synth aesthetics is directly linked to the development of house and techno music in the late 1980s. In the summer of 1988 there was an explosion of electronically based dance music in rave and club culture. Much of this had its origin in Detroit, but it soon spread to the major cities of England and Germany (Rubin 2000, 111). Though much of this music formed part of a short-lived movement, it had a profound impact on the further development of all popular electronic music. The premise for the creation of this music was directly linked to technical innovations, but in a reactionary way. Academics writing on music technology in 1990 claimed that digital sound devices had taken over from their analog counterparts (Durant 1990, 181). In the formation of this new electronic music scene however, a series of discontinued analog machines produced by the Japanese "Roland Corporation" played a very important role. These were the drum machines TR-808 (1981) and TR-909 (1984), and the bass sequencer TB-303 (1981) (Berk 2000, 193). One reason for their discontinuance was that the early 1980s saw an emerging interest for drum machines featuring digital samples of real drums. For the average musician there was an obvious advantage of having a drum machine that actually sounded like drums, which was not the case with Roland's analog drum machines. In spite of this, Roland's president Ikutaro Kakehashin did not want to abandon the analog sound. In 1984 they released the TR-909, which he believed had the perfect blend of analog sounds and digitally sampled sounds (Vail 2000, 284). The cymbals and hi-hats were digital sounds, while the actual drums were still produced through analog circuits. The machine was not a success, and the year after it was replaced by the TR-707, featuring only sampled sounds. In conjunction with the release of the TR-808, Roland had also released the TB-303, a small portable device marketed as an electronic substitute for a bass player. As with Roland's drum machines, the TB-303 did not sound much like its real-life counterpart.

By the end of the 1980s, all these devices were considered outdated and were therefore cheap to buy on the secondhand market. For young and poor musicians these devices therefore became a starting point for making music, and instead of ending up sounding outdated, the use of this old equipment reinvented the sound of popular music. The deep "boom"-like bass drum sound of the TR-808 soon became a favorite with the emerging hip-hop acts (Cutler 2000, 111), whereas the more tight and punchy sound of the TR-909 defined much of house, techno and trance music. For bass-lines, the cheap TB-303 was a natural choice. By turning its resonance filter to the max, the machine would generate the extreme synth wail which came to define the style of Acid House.

The use of TR-909, TR-808 and TB-303 sparked an increasing interest in older synthesizers and drum machines. There was of course initially an economic reason for this renewed interest, since at that time the older analog equipment was cheap. However, this does not suffice to explain why the trend continued through-

out the 1990s. In his book "Strange Sound", Timothy Taylor tries to explain the continuing trend by relating it to musicians' growing interest in earlier styles of popular music. However Tim Gane from the band "Stereolab", when interviewed by Taylor, claims that the only reason he uses old equipment is because he likes the sound of it, and does not link it to his interest for earlier popular music (Taylor 2001, 112). Another fact that speaks against Taylor's idea of retro romantics is that musicians in the 1990s used the old equipment in different ways than their manufacturers had intended. Music producer Trevor Horn recalls that, during the mid 1980s, he tried to think what a drummer could do while programming his drum machines.

> Nowadays people don't have a clue what a drummer can do, but they make the box go 'do do do da do baf', and it's fantastic, it's great …….. The way people get in to this sound these days is really quite unbelievable (Warne 2003, 146).

In addition to this, machines like TB-303, TR-808 and TR-909 were rarely used in popular music around the time they were in production. Thus there seems to be no definite link between a cultural nostalgia and the use of these vintage musical devices. This brings us back to the aesthetic dimension of technology, and again to the distinct difference in sound between analog and digital equipment. In the same way as the errors and inaccuracy of analog recording technologies were crucial in defining its sound, distortions and noisy sound in analog synthesizers is what makes them stand out from their later digital counterparts.

Amongst musicians, analog synthesizers and drum machines are, alongside other analog recording tools, described as having a "warmer" sound. Jim Scott, an engineer who worked at the Moog factory during the 1970s, has a personal theory about the sound of the analog synthesizer that can explain why it sounds "better" than its digital counterparts. As he explains, the internal sound processing of an analog synthesizer is done using the total frequency range of a sound, and even if you can't hear all these frequencies, they will affect the distortion of the sound (Pinch and Trocco 2002, 235). In digital processing of sound you can only work with a limited range of frequencies defined by the sampling frequency of the sample. Because of this, digital sound cannot be distorted in the same way as an analog, and therefore produces a "thinner" sound.

Why then, if digital equipment sounded so bad, did people start producing and using it? Besides producing a different sound, there were many productional and functional advantages of digital equipment. As mentioned earlier, digital recording enables a greater flexibility in editing. When it comes to sound productions, digital technology has made possible new ways of synthesizing sounds, such as the FM synthesis in the Yamaha DX7. Sadly, the manufacturers at one point made

a turn in the development of digital synthesizers that was unpopular among many musicians. This happened when manufacturers started to focus on the possibilities of digital technologies in reproducing accurate sounds and copying real life instruments – in academic terms, trying to render the synthesizer transparent. While the traditional analog synthesizers had oscillators that produced square, sine and sawtoothed waveforms, the digital synths gradually exchanged these for sampled waveforms from actual instruments. In this way the synthesizer could hold a large sound repertoire of more authentic-sounding instruments. Among the first to use this technology was Korg, with the release of their M1 waveform synth in 1988 (Manning 2004, 301).

From the increasing interest in analog synthesizers in the late 1980s it can be concluded that it was precisely their failure to reproduce actual sound that made the analog synthesizers and drum machines aesthetically interesting. This analog equipment was especially used in the emerging dance music scene. In the beginning this was a result of economic concerns, but it eventually became the dominant aesthetics (Gilbert and Pearson1999, 124).

Functionality in analog technology

The reuse of analog synthesizers was not only motivated by their unique sound, but also by their functional advantages. The earlier analog synths usually had all their parameters accessible to the user in form of knobs and sliders. A good example of this is the design of the "minimoog", the first portable synthesizer to be produced. It was deliberately constructed with easy-to-turn knobs so that the musician easily could manipulate the sound while playing. According to Robert Moog, the inventor of the moog synthesizer, it was designed to be a musical instrument in all ways. It was not only an easy-to-play keyboard, but also a fast and intuitive instrument for sound production (Pinch and Trocco 2002, 224). With the introduction of more and more digital devices in the 1980s, these functions gradually became hidden behind a series of key combinations, resulting in a growing dissatisfaction amongst musicians. Today, manufacturers have learned from their mistakes and have reintroduced designated programming knobs.

Giving the user access to the programming parameters of a musical production tool gives the user only partial freedom. To achieve a greater freedom, the devices have to be turned "inside out", enabling the user also to configure internal structures of the machines, thus creating what is called a modular system. In the 1960s and early 1970s this was the standard design for synthesizers. The user can connect the components of the machine by using patch cords to arrange the path of both audio and controller signals. While the audio cords define the route of the

sound through the system, the controller signals define how each module transforms the sound.

These modular systems of the late 60s and early 70s, were, and still are, extremely expensive and offered perhaps a bit too much freedom for the user. Still, the patch system lived on in hybrid synths like the Korg MS and PS series (produced 1977-1983). In these devices, some of the hardwired system can be overridden by a patch panel. The advantage with devices like these is that they can easily be used to manipulate sounds from external sources. By connecting them to other devices, the modules can be used as signal processors, transforming the sounds of other synthesizers and traditional instruments. In this way the modular system not only functions as a user interface, but it also doubles as communication standard between analog devices (fig. 2). These patch cord systems have a great flexibility in manipulating sounds, but are harder to use when it comes to sequencing melodies. When the synthesizer gradually became digital, the digital communication protocol MIDI (music instruments digital interface) was introduced to replace the analog patch cord system. The standard features of this system were mostly based on sending and receiving keystrokes from a keyboard, and not on distributing the actual audio signal. In this way the MIDI system was very good for notated music, but not as well-suited to manipulating sounds as the earlier analog system.

Figure 2

With the introduction of graphical music software, the functionality of modular systems has had a tremendous renaissance. In an academic context, this type of emulation or copying of functional aspects from older technology into newer media is usually understood as an attempt to draw on the user's familiarity with

earlier technology. The use of the desktop metaphor is a prime example of this. This metaphor was established to give the user a familiar ground upon which to communicate with a computer in an office setting. In reference to musical production programs and equipment, the remediation of earlier devices must be understood in a much broader sense. In understanding for instance the Arturia virtual version of the Modular Moog system ("Moog Modular V soft synth"), familiarity cannot be the primary motive, simply because few of today's users have experience with modular Moogs. Thus, the motives for reproducing older user-functions in these cases are based on their creative abilities rather than as recognizable metaphors. The "Reason" software has several functions that are taken directly from the analog modular systems, which cannot be seen as merely functional metaphors either. An example of this is the "Matrix sequence", a module that sends out a cv-signal[1] varying in relation to user defined patterns (fig 1). By connecting a virtual cable to other devices in the program, all sorts of parameters can be controlled resulting in a rhythmic change in the sound structure. By reintroducing this vintage control system, unfamiliar to most young musicians today, "Reason" achieves a greater flexibility than what is found in more notation-based midi sequencers. Another software that is strongly based on the modular system is "Reactor", produced by Native instruments. Here you also use virtual cables for audio and controller signals to connect different components inside the program.

The use of digital tools in the 1990s

As I have shown, the development of commercial digital music tools in the 1980s did in some areas move away from what many musicians preferred. The digital devices lacked many of the sonic and functional aspects that electronic musicians looked for, and were therefore unable to make analog technology obsolete. However, the music technology in the 1990s was not purely an odyssey through vintage hardware. What many people associate with electronic music in the 90s is in fact the digital sampler. Although this can be seen as a contradiction to my claim of the importance of analog technology, I will argue that the sampler played an essential role in forming an aesthetics based around analog sound. The reason for this is rooted in how the sampler was used in the electronic music scene.

Originally an invention of the 70s, the drop in digital hardware prices made the sampler available to the general musician in the late 80s. Its design principle is the same as that of digital recording, taking samples of a waveform and storing them as digital information, hence its name. The invention of the modern sampler became fact when the digital information successfully was put in RAM memory cir-

1 Short for "control voltage signals" used to control parameters in a modular system.

cuits, easily retrievable by a keyboard controller. However the actual novelty of this design can be debated. The idea has much in common with the "Mellotron" of the 1960s, which stored actual analog sounds on different magnetic tapes attached to the keyboard.

When engineers started working on what eventually became the sampler, they wanted to create something similar to the M1 synthesizer, which could recreate the sound of traditional instruments. However, when the sampler became affordable for the general musician, its cultural impact was different. Nowadays people associate the word "sampling" with recording parts of music and reusing them, and not as a description of how analog/digital converters work. Taylor claims that using the sampler as an actual musical instrument is consistent with sampling and re-contextualizing parts of existing recordings, and not only with using it to reproduce traditional instruments (Taylor 2001, 152). In this way the case of the sampler fits in perfectly with a general discussion of digital reproduction. Andrew Goodwin's article "Sample and Hold" is one of the earliest examples of this. Here he discusses the sampler in view of Walter Benjamin's concept of "aura" (Goodwin 1990, 259). The understanding of the sampler as a recording device is also promoted by Chris Cutler in his article "plunderfonics". Here he views the sampler as a technical culmination of a "low" cultural tradition of using other people's recorded work as a basis for new artistic production. He claims that digital technology made sound piracy so easy that it made no sense not to engage in it. "Producing could be no more than critical consumption; an empirical activity of 'Pick 'n' Mix'" (Cutler 2000, 101).

A very peculiar aspect of the discussion around sampling was that it also crossed over into other cultural fields. In the late 1990s, there was a trend amongst some Norwegian authors to deliberately incorporate long quotes form other texts as an artistic strategy in their novels. To describe and explain this practice, many critics used the term "literary sampling". In 2001 Sussane Østby Sæther and Elin Fallen (2001) wrote an article, called "En Røff Guide til Sampling" ("A Rough Guide To Sampling"), which successfully demonstrates how sampling was perceived around the turn of the millennium. Their main point is that sampling is an aesthetic strategy based on a deliberate form of intertextuality, where the reader/viewer/listener recognizes the works as collage-like compositions based on well know elements. According to this view, sampling occurs when a specific element is deliberately moved from one context to another, and interpreted by the reader/viewer/listener in its new context. In this way they claim that the practice of sampling has much in common with the poststructural theories of Roland Barthes and Mikhail Bakhtin. It must be pointed out that their views are derived from a literary perspective, but they also claim that much of this is evident in musical and pictorial sampling.

Much of the academic understanding of "sampling" as an artistic concept is due to its appropriation by the existing discussion around intercontextualisation and digital reproduction. As Sæthre and Falles article shows, when combined with this existing discussion, sampling fits into a very neat theory. Another example of such a theory is Lev Manovich's account of artistic creation in new media as the selection and combination of preexisting elements, thus blurring the distinction between producer and consumer (Manovich 2001, 135). My question in regard to this is: how accurate are these theories in describing the effect of sampling technology on musical production? There is no denying that there are many examples where the sampler has been used to fuse parts of older existing recordings into new songs; the recontextualisation is an important aspect of the aesthetic experience. But if this is to describe all about the sampler, a sample must be something that always has a prior existence in different context to the sampler. In this view, the "sample" is something that is found (Sæther and Fallem 2001, 5). These thoughts promote the recording aspect of the sampler and its ability to reproduce something already existing. But as with the earlier described recording technology and sound devices, the use of tools for the production of music has a variety of effects. As Gert Lovink puts it: "The sample is not the expression of a fragmented world, it's the technological a priori of all information" (Lovink 2002, 259). This means that a "sample" can just as well be something new, and not existing prior to the sampling process. Even when basing a sample on an existing recording, the reuse of it does not have to result in a deliberate recontextualisation, but rather in the creation of a new cultural experience. An example of this can be seen in the use of the so called "Amen Break", a seven second drum rhythm sampled from a 1967 recording of "Amen Brothers" by the soul band "The Winstons". Although it is maybe the most frequently used sample, its origin is not generally known. According to Nate Harrison it has been used so much that it has become a part of our cultural subconsciousness, freed from any reference to an original context (Harrison 2004).

Harrison's account of the "amen brake" also shows how it was radically edited and rearranged and became an essential part of the aesthetics of drum and bass. In this use, the only thing remaining of the "amen brake" is the sound of the drums, not the rhythm. In this way we return to the important question of the aesthetics of sound, and especially vintage sound. From my point of view, the recording aspect of the sampler has not only been used to cut and paste from known songs, but also as a way to recreate the analog sound. When listening to music, most listeners will never recognize where a sample originates from; the only thing that gives it away as a sample is often its vintage sound. In this way the listener will not experience a recontextualistation of a specific musical piece, but rather a reuse of earlier sounds. This reproduction of analog sound, for instance vinyl sound, has been regarded as an act of romantic nostalgia (Norman 2004, 187). Holding this opinion,

however, would mean missing out on all the creative innovations that have come out of experiments with earlier technology.

Digital reproduction of analog inaccuracy: a technological counterrevolution

When looking at how electronic musicians perceived the musical technology in the 1990s, we can perhaps sense a slight hint of technological determinism. By experimenting with older analog technology, the importance of the material technological aspects in forming a new expression became evident. The cultural use of technology had assigned aesthetic dimensions to audio tools, which carried great implications for the production of popular music. As a result of this material aesthetics, the creation of diverse musical expressions demanded a range of different technological devices. The problem that then occurred was that many of the discontinued synths and drum machines people wanted had become increasingly scarce and expensive. To get around this, people started searching for ways to regenerate the characteristics of different-sounding technology. Rather than merely seeing the sampler as a tool for deliberate melodical retextualizing, I believe it also played an important role in this regeneration of the older pre-digital sounds. Thus, sampling music from older recordings was not only motivated by a desire to recontextualize the melody, but also by a desire to recreate the sonic quality of the recording. This is particularly the case with drum samples, which can easily be reedited removing the resemblance to their original rhythmic use. If musicians sample acoustic drums, they generally prefer recordings from the 60s and 70s such as the "Amen Brake". These sounds were recorded with older analog equipment and have all the sonic quality of vintage technology. The sampler also turned out to be ideal for sampling sounds from old analog drum machines and synthesizers. In this way the sampler was not used to make accurate reproductions of acoustic sounds, but rather to reproduce the "inaccurate" sound of analog technology.

In the 1990s analog sound not only lived on through the use of samplers; manufacturers also saw this as an opportunity to start remanufacturing some of the earlier analog equipment. First out was a range of TB-303 reproductions, but it soon became evident that larger analog devices were too expensive to produce today. When the chief designer of Korg was asked whether he would start producing some of the old equipment, like the MS-20, he said it would be much more expensive to produce than the digital devices they now manufacture. This problem of economics was what eventually sparked the production of software synthesizers. Once again the legendary Roland TB-303 was among the first to be reproduced as software, under the sacral-sounding name of "Rebirth" (1996). These types of software are designed to simulate the circuits of the original device, recreating how its different components affect the sound. In this way the program

can reproduce not just a single sound, but also the device's flexibility of sound synthesis.

At first glance, the software synthesizer might have much in common with the concept of remediation**,** but the key difference lies in the motivation behind its construction. The quest for transparency**,** which is so important for much of Bolter and Grusins understanding of remediation**,** is turned upside down by the software synthesizer. As I pointed out earlier, a musical tool that does not make a mark does not fit into the creative concept of electronic music production. As a consequence, the traditional concept of media transparency becomes comparatively uninteresting: digital transparency is only interesting when it is used to recreate the inaccuracy of analog tools. In this way the computer continues what the sampler started, namely the reproduction of the analog sound aesthetic that was lost with the introduction of the first digital tools. The software synthesizer is a result of a technological counterrevolution, fueled by a desire to revive pre-digital tools. Musicians do not look for transparent tools because the tools themselves have become an important part of the creative process.

Since academics in the field of media science mostly look at how we consume visual culture, they fail to recognize the rather strange relation between technological evolution and musical production. Because of this, they also miss some unique aspects of media technology and the production of cultural expressions. If we go back to the opening example of the computer functioning as a typewriter, a media scientist like Manovich would describe this as a misconception typical of the early age of digital media when the computer was perceived only as a tool. During the 1990s, he claims, this misconception was replaced with a growing awareness of the computer as a meta-machine for production, storage, distribution as well as media access (Manovich 2001, 69). This might be true in the realm of consumer electronics where it is popular to view digital media as blurring the role of the viewer/reader in relation to the producer. However, for musicians and probably many other specialist groups, the computer is most of all a tool for production. Being a meta-machine therefore involves an ability to function as diverse tools. In this specialized context, Manovich´s view that the computer has closed the gap between consumption and production becomes no more than a myth created outside the realm of artistic and cultural production. The true strength of the computer is that it sets the producer free, and gives him or her the choice too still use the typewriter if he wants.

What makes the computer interesting in the realm of music production is its ability to recreate the functional material aspects of earlier tools. The unique aspect of software synthesizers is that they do not just recreate the results of earlier tools, but also the tools themselves. Since music production in a sense is technologically deterministic, the computer as a meta-machine must also have to repro-

duce this technological materialism. Photo editing software strives in some instances to achieve the same materialistic aspects, though the use of plug-ins that try to copy the techniques of, for instance, crayon drawings. But the programs do not give you any actual crayons, they just add an effect that makes the picture appear as if it was produced with crayons. In the same way, today's metaphorical user interfaces do not have a functional materialistic resemblance to their real life counterparts, but are usually based on metaphorical resemblance. The files on a computer do not function like real life paper files, whereas the software synthesizer functions are as close to the original as possible. This makes the software synthesizer stand out from other acts of digital remediation. In this way, new media in the production of popular electronic music *is* analog media converted to digital representation, a statement Manovich claims to be more or less a popular myth (Manovich 2001, 49). In my view, the biggest achievement of digital technology is not the recontextualisation of text, but rather the provisions of tools. In order to recontextualise an earlier recording, no more than magnetic tape and scissors are needed, recontextualizing tools themselves on the other hand is a quality only attributed to digital technology.

However**,** the emergence of software synthesizers, even though its development seeks to revive analog technology, must not be seen as act of retro romantic. From the reproduction and recontextualisation of earlier tools, it is only a short way to start creating new tools. A good example of this is in fact Propellerhead's "Reason" software, which contains a series of vintage-like devices, but unlike "Rebirth", these devices have never existed in a physical form. All the synths, samplers and drum machines come with a distinct name and design; one can even read the serial number and production date on some of the virtual devices, dating them back to the early 1980s, even though they are all new inventions by the software designers. "Reason"**,** therefore, presents itself as a simulation, but a simulation without an original. As argued above, since many people never have used the machines in real life, remediation of musical tools is not only about familiarity with older tools. People use the software versions of analog equipment because they want to achieve a specific sound and not because they already know how to use these tools. The motivation for software simulations is therefore driven by a more general cultural idea of analog technology, not merely by a wish to recreate specific historical tools. For the user the question is not whether or not "Reason's" tools have existed in real life, but rather that they correspond to the cultural idea of analog equipment superiority over digital technology. The counterrevolutional aspect of the software synthesizer is not about going back in time, but rather about the fact that the digital revolution as we know it has ended.

Convergence and divergence: the contradictions of digital technology

Some might claim that my argument about the software synthesizer as proof of the end of the digital revolution in fact proves the opposite. The computers' ability to reproduce analog equipment could easily be seen as the triumph of digital technologies. This view fits very well into the notion of media convergence, where all tools can be fused into the computer. But there are two problems in regard to this opinion.

The first problem with musical software is the lack of tactile aspects, a problem it shares with most other digital tools. As I have argued earlier, much of today's software, like "Reason", is trying to recreate not only the sound of analog technology, but also the functional aspects. The recreation of the latter is even more problematic than the recreating of analog sound itself. As I have pointed out above, analog equipment is renowned for its tactile controls, an aspect lacking in the traditional PC. Turning virtual knobs with a mouse simply does not feel the same as handling physical buttons. The digital tools are therefore lacking all of the performative aspects of early analog synthesizers. To solve this problem without spending a fortune on hardware, it is now possible to buy general purpose midi controllers that feature numerous slides and knobs. By attaching one to the computer through a USB port, it can be assigned to control the digital parameters of your software. An example of this can be seen in "M Audios" midi controllers, which combine piano-keys, knobs and faders. In addition to these general purpose controllers, there are also controllers made for particular software, such as the scaled-down Korg MS-20 that functions as a controller with the softsynth version. Because of this, it can be argued that even if the computer should manage to recreate the sound of analog technology, the computer as a physical device cannot be a substitute for the functionality of hardware. In this way, much music software is forcing the digital technology beyond its normal physical restrictions.

The second and most problematic issue with digital software is of course sound. As mentioned above, digitally created sounds are structured differently from analog sound. Even though a digital software version of a Korg MS-20 might sound like an analog synthesizer, the superior sound quality of the hardware version will by comparison make the software sound like something you really do not want to spend money on. As previously mentioned, Bolter and Grusin's concept of remediation implies that newer media reproduce older media as an act of supremacy over the older media form. Now, if we see the software synthesizer in relation to this, the remediation has much the opposite motivation when comparing digital and analog sound tools. The remediation of analog tools is in most cases accompanied by a growing consciousness of the lack of sonic qualities in traditional digital tools. There are of course many practical and economical advantages of digital

technology, but there is always a sense that analog hardware can produce a "richer" sound. In a sense**,** digital musical tools have gone in the opposite direction than other digital media, and thus working against the "traditional" digital revolution. In opposition to the way all academic writing describes the evolution of digital technology, the more powerfully the computers have evolved, the more normal it has been to view digital musical tools in terms of a "horseless carriage", promoting what is lacking in digital media. In this way the software synthesizer re-actualizes the original analog equipment and digital tools are, in fact, eating themselves. When "Reason" makes a simulation of a series of imaginary analog devices, the program in reality helps to strengthen the notion that analog equipment is superior to digital. It is very much this notion that defines the need for this type of musical software. In addition, the way that "Reason" defines music production as a process involving a diversity of separate devices, works against the idea of the computer as the only production tool. In this way the convergence resulting from the production of software can be seen as fueling a technological divergence: namely, as upholding an interest for real analog hardware.

Conclusion

The conclusion of this article is that digital technology in music production does not have the novel status one might expect. Digital tools exist in a close relationship with their more vintage analog counterparts. The real novelty of software lies in its ability to respond to this relationship and revive instruments from the tar pits of technology, and to let people use them in new musical contexts. The strength of digital tools in the dawn of the 21st century lies not in their ability to copy and manipulate earlier texts, but rather to simulate and manipulate earlier tools, allowing the user to choose amongst all previous devices and even create new ones. Even though the software has many practical and economic advantages, it has to live up to the user's analog sound ideal. Furthermore, by following this quest for analog sound, digital technology helps to create an acknowledgement of analog aesthetics. This must not be seen as merely an act of nostalgia, but rather as a sense that the context of its use is what really makes a particular technology novel. The growth in popular electronic music is to a great extent a result of experimenting with cheap and outdated technology. Instead of always searching for new and better technology, electronic musicians have based their innovation on using whatever they could find and combining this into new cultural expressions. In musical production, the computer software is at the forefront of an ongoing technological divergence, where artistic expression is a result of both different technology and different usage. The success of the computer as meta-tool is not so much a result of the aesthetic qualities of digital technology, but rather a result of the cultural significance that vintage technology has achieved in opposition to the earlier digital production tools.

Though the development of musical tools differs a lot from how academics generally perceive technological evolution, one might**,** strangely enough**,** find a resemblance to this in how Marshal McLuhan described the fate of the horse after the introduction of the car. As McLuhan points out, the horse didn't disappear; it just changed its function from being a means of transportation to a means of leisure and entertainment (McLuhan 1964, 238). This might seem a strange comparison, however it illustrates the idea that new digital tools will not digest all earlier analog media. It also raises the awareness that novelty isn't all, and that older medias and technologies will live on and maybe even have a revival by being used in a new and different way. The introduction of new digital media has given us a choice; we don't use analog technology out of necessity, but because we want to. Our way of choosing is not necessarily linked to technical development, but rather to the cultural significance of material aspects and usage. It has too long been a tendency to make generalizations about the impact of digital media by focusing on the same empirical material, the consumption of visual culture only. By focusing on production of music, I hope to have brought some new empirical material forward and to have demonstrated alternative approaches in understanding the relationship between technical innovations and cultural expressions.

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