

Technology, Society, Industry and Music Production: The changing roles of the Record Producer and the Recording Engineer since 1970

Sarata Persson

Arena Media Music and Technology
Piteå School of Music
Luleå University of Technology
-2006

Technology, Society, Industry and Music Production: The changing roles of the Record Producer and the Recording Engineer since 1970

Sarata Persson

Arena Media Music and Technology
Piteå School of Music
Luleå University of Technology

Supervisor: Nyssim Lefford
Sonic Studio, Interactive Institute, Piteå

Abstract:

Over the past three decades, in the recording studio many extensive technical changes have occurred. This has changed the way music is produced. Other factors have also greatly influenced music, studio production and the role of the producer and the recording engineer. The Internet, digital formats and industry standardizations are believed to have caused changes too. Specifically, the computer industry introduced many digital technologies over these decades. At the same time, the music industry changed as did consumer habits. As a result, current production practices - the techniques of and aesthetic application of technology to recording - have been shaped by several outside influences that include both technical and business factors. Since the 70's, the computer, music, and audio industries have begun to influence one another. The purpose of this research study is to identify in which parts of the production chain the changes have occurred and begin to assess what their impact has been on the roles of the producer, engineer and music produced. Findings from this study may help us to understand the connections between outside industries and the audio industry and analyze how they can affect production tools and production practices.

The scope of this study will be constrained to a cross examination of technological changes in recording equipment, changes to the amount of time producers and engineers spend on particular parts of the production process and what topics/decisions are discussed in the recording studio, but also technical, social, business and changes will be correlated to link change to cause. The methodology for this study contains of two parts. The literature study provides a background and a basis for analyzing what has happened, formulating speculations about how it happened, and predicting what may happen in the future. The experiment uses questionnaires that have been sent out to producers and engineers from Sweden, USA and the United Kingdom. The questionnaire responses have been compared to each other, but also considered against findings in existing literature. Indications from this research suggest that changes have happened in the whole music production chain and in some aspects also on the studio roles. The shift to digital technology has had the greatest impact on how recordings are made, but also consumers and the music industry have had an important impact.

Thank You's:

My greatest appreciation and thankfulness I give to my supervisor Nyssim, for supporting my ideas and helping me with my research. A great deal of appreciation I also send to all who have contributed to this research through the questionnaire and in other ways. Finally, a thank you to all of those who have believed in me.

Content:

Abstract	3
1. Technological History	7
1.1 Introduction, history	7
1.2 Purpose and Scope	7-8
1.3 Important technology that came out of the 60's	8
1.4 Technical changes in the 70's	8-9
1.5 Technical changes in the 80's	9-10
2. Analog and Digital Differences	10
2.1 Difference between analog and digital technology presented in the 80's	10-11
2.2 Differences between analog and digital equipment and how they work presented in 2001	11-12
2.3 Differences between analog and digital equipment and how they work presented in the 80's.	12-13
2.4 The quality of digital recording sound presented in the mid 80's	13
2.5 Summarized comments about the differences presented in techniques and working methods in 2001 and the 80's	14
3. The Digital Revolution	14
3.1 The Integrated Circuit	14
3.2 The computer technology	14
3.3 The Importance of Standardizations	15
3.4 Things that made the digital revolution possible	15-16
3.5 Affects of the digital revolution personally presented by an engineer	16-17
4. The Digital Audio Workstation (DAW)	17
4.1 DAW editing functions	18
4.2 DSP (Digital Signal Processing)	18
4.3 Plug-ins	18
5. Internet, File Transfers & Digital Storage	19
5.1 Internet & Networks	19
5.2 P2P	19
5.3 Data storage	19-20
5.4 The compact disc	20
6. The analog recording Chain vs. The Digital Recording Chain	20
6.1 The analog recording chain, versus the digital recording chain in studio production	21-22
7. Society	22
Societies impact on the changes	22-23

8.	The Music Industry	23
	The music industries impact on the changes	23-25
9.	Studio Roles in the 70's and Studio Roles Now	25
	Studio Roles in the 70's and Studio Roles Now	25-26
10.	The Experiment	26
	The experiment	26-27
10.1	The questions asked for both the producers and the engineers	27
10.2	The Questionnaire both producers and engineers	27-31
10.3	Important findings of the questionnaire producers	31-34
10.4	Important findings of the engineer questionnaire	34-37
10.5	Analysis questionnaires	38-39
11.	Discussion of the literature review and questionnaire responses	39
	Discussion of the literature review and questionnaire responses	39-41
12.	Conclusion	41
	Conclusion	41-42
13.	References	43
14.	Appendix questionnaires	44-56

1. Technological history:

Throughout section 1, the history of technology in audio and recording will be reviewed, from the analog equipment of the late 1960's and through the shift from analog to the contemporary digital recording studio.

1.1 Introduction, history:

We went all the way from Edison and Berliner to acoustics recordings to broadcasting, electrical recording and magnetic tape, and then to the multi-track recording studio and finally into the era of the computer, digital media and the Internet in a relatively few decades. [1] Through out the history of audio technology, outside industries have always had an impact on the audio industry and studio productions, but since the 70's there has been some changes in how non-audio technologies have influenced production and this will be discussed in the paper. The music industry the ones who distribute records to the masses, has played its part in it. Consumers have not only been major supporters of recordings, but also of other technical products, supporting changes in playback equipment and home recording technologies. But since the introduction of the IC and digital technology by the computer industry, the rate of change and the character of outside influences on recording practice have changed drastically. After the computer we got the Internet that provided a new way to distribute music, and this also provided the platform for new formats like mp3, mpeg, and wav. This led to the rise of the P2P (peer-to-peer) file sharing technology. These factors contribute to the changes seen in music and studio production, this will be discussed throughout the paper.

1.2 Purpose and Scope:

The main purpose of this research study is to identify in which parts of the production chain the changes have occurred and begin to assess what their impact has been on the roles of the producer, engineer and music produced. Findings from this study may help us to understand the connections between outside industries and the audio industry and analyze how they can affect production tools and production practices. The scope of this study will be constrained to a comparison of technological changes in recording equipment to the amount of time producers and engineers spend on particular parts of the production process and what topics/decisions are discussed in the recording studio, but also technical, social, business and changes will be correlated to link change to cause. The digital revolution brought aesthetic changes as well, but this first investigation does not extend that far because technology, society and business have all influenced aesthetics. Understanding how these factors impact each other and the production process generally provides a basis for understanding how all these things influence the music itself.

The following literature survey is not meant as a complete history of the recording industry, but a review of certain technologies from about three decades that substantially shaped the current technical environment. Each technology covered will be examined in terms of how they evolved, that is how equipment changed, got more advanced and offered more functions. These technical changes altered the recording process and post production in the studio. The efforts of the engineering and audio research community focused on improving the techniques for accurate recording and reproduction of an audio signal that is recording without bringing in any distortion or noise. [1] This however changed with digital technology. Suddenly we had the ability to create artificial sounds and apply digital signal processing as never before. This has clearly helped music production to move forward. Because of digital technology several new music genres exists today, some of which were not possible in the analog days and we see that analog equipment is used today mainly as an aesthetic/artistic choice in recordings. Since the introduction of digital, technical advances and improvements have

happened more quickly. Possibly the eagerness to create new technologies has exceeded our desire to make the current digital technologies stable. Have we sacrificed some things for convenience? Maybe the tools encourage/discourage some kinds of production techniques? These questions will be explored in the following pages.

1.3 Important technology that came out of the 60's:

Out of the 60's the first multitrack records made their appearance. The Beatles used a 4-track multitrack recorder to record their album: "Sgt Pepper's Lonely Heart Club Band". With the multitrack recorder this meant that sources could be recorded separately and after that individual tracks could be panned (placed in the stereo field), though without exact precision, to left and right in the stereo mix. [2] Other technologies from the 60's, such as the digital audio PCM recorder (Pulse code modulation), were also important in shaping the technology of the 70's. These two pieces of important equipment would remain in use for a long time. The first demonstration of the PCM recorder was held in the late 60's, in 1967. [1] The impression of most listeners who heard the first public demonstration was that the fidelity of the sound produced by the digital equipment could not be matched by any conventional, analog tape recorder. [3] Another influential technology was the two head helical scan VTR, who was the recording medium. [1] Early devices used helical scan video tape recorder as storage device was because it offered the most bandwidth and storage capacity that was available. [3]

The main reason conventional analog tape recorders caused such a deterioration of the original signal is due to the magnetic material on the tape itself. The material contains irregularities present before anything is actually recorded. With digital technology we no longer needed to compensate for the limits of analog technology. Another problem is that the analog medium itself is non-linear and it is not capable of recording and reproducing a signal with total accuracy. Distortion therefore exists everywhere along the signal path on the analog tape recorder. The digital recorders like the PCM recorder on the other hand is linear and has the ability of recording and reproducing a signal with total accuracy and even if the recorded signal is distorted by tape non-linearities and other causes. [1] These are important differences between analog and digital that impact how each medium sounds. Digital equipment has many advantages and helped the recording industry to move forward.

1.4 Technical changes in the 70's:

Digital devices were no longer only in theoretical. In the early part of this decade it became a reality. Some technical challenges however did exist. One challenge dealing with digital audio in the 70's dealt with, that it required the means to both capture and store it in real time. Also a problem with retrieving the large amount of digital data that was being produced at a very high rate was a challenge. This would be an existing problem until recording equipment could be designed and built with available high-speed and high-precision converters. Analog- to-digital and digital- to- analog converters were both very unstable and expensive devices. During this time wide spread laboratory research was happening all over the world in order to develop digital recording machines.

Few designs though created in research laboratories became reality. The first commercially available digital multi-track recorder came in 1978. Other developments were followed. Around this time developments approaching the final product of the compact disc started to occur, potential digital carriers were demonstrated, also developments on hard-disk-based editing systems was on the way. In 1978, the Soundstream's digital editing system was put into use. At this time the potential of the emerging digital signal-processing techniques was

shown publicly. At the end of the 1970's, AES started on standardization work within its technical committees to support the exchange of digital audio recordings and data under the set of standardized formats and protocols. [3] This was met by the threat of legal action, which temporarily slowed down the process of standardizations. [4] It was a short lived threat. [3] In 1978 an important standardization was accepted by the AES; the agreement upon setting the sampling frequency of 44.056 KHz as standard. This was to play an important part for the future of digital recordings.

The multi-channel recorder is probably the most important equipment in recording studios. A digital tape recorder would be more desirable because dubbing can be performed endless times without loss of sound quality, and there is no cross-talk obtained between channels. This is not possible on an analog tape recorder. On the other hand it would be difficult to maintain satisfying audio standards if a digital audio processor is combined with a VTR, since the reason being that editing on VTR systems is quite difficult to perform. The answer to this problem was the fixed head digital tape recorder, but since its introduction a number of problems needed to be addressed which required much of research in the 70's to fix them. Error correction codes were also developed in order to fix some problems. In 1978, it also happened that there was a lot of testing of speakers using PCM recorders. This meant that the audio industry had taken a major step towards true fidelity to the original sound source on both the recording and reproduction ends of the chain.

The first commercial processor for domestic use according to the EIAJ Japanese standard gained great popularity. This was the PCM-F1 presented in 1982. Its qualities were so outstanding that it was immediately used on a large scale in the professional audio recording business and helped quickening the acceptance of digital audio in the recording studios. By the end of the 1970's, the industry was near to reaching the level above which few further improvements on analog equipment could be made without dramatically increasing the price on it. Analog reproduction techniques had just about reached the limits of their characteristics. [1] A lot of important developments and equipment came out of the 70's. It was clearly a very important decade technologically. The major discovery of this decade, being able to digitally store and capture musical signals in real time, was very important since it plays role in how the digital recording system works.

1.5 Technical changes in the 80's:

By the time of the third AES conference [5] on digital audio in 1989, the focus was directed towards improving the quality of the first generation of digital equipment, with the likes of higher resolution capability and more linear converters, but also improving digital signal processing in the whole recording/reproduction chain. Digital audio was by now no longer a new phenomenon and was becoming widely adopted. By the mid 1980's, digital audio was becoming more and more mainstream and this could be seen because of the increasing number of papers on the subject digital being presented in the AES Journal. More progress was being made. Dither was now frequently applied in digital audio signal processing as a result of engineers becoming better educated about digital audio. [3] Dither is low level noise signal that is added to the audio signal before conversion in the D/A process. This feature help randomize the error of quantization noise that occurs during conversion. [2] Digital workstations were now available. Analog-to-digital converters were being improved. Another important event was when AES, in 1985 published its first digital audio standard, with the name of AES3-1985, on the AES/EBU serial interface, which soon became a universal standard used in the audio industry. The pace of research and developments continued to accelerate in the 90's caused by needs in areas of application such as digital film, television,

Internet and computers. One common criterion for the use of digital audio in all of these media is the need to conserve storage space and/or transmission bandwidth, that is, data compression usually with a loss of inaudible data. Every decade saw achievements that were unthinkable the decade before. Rapid changes have happened had a dramatic affect on the audio industry. [3] Kikuta explains that by 1985 the digital audio recording system had been put into use for more than 10 years, and during this time, because of the progress made in semiconductor and signal processing technologies, the circuitry had been miniaturized, the performance had improved and the use of professional recording systems had grown. In addition, he writes that digital technology has influenced all kinds of sound processing devices in general and especially studio time-delay equipment. New sounds which could not have been produced by analog devices have been created thanks to digital equipment. As a result of the digital domain, present-day recording studios now work in a more virtual world. In 1985, digital audio recording systems had not yet become standard equipment in the studio. [6]

2. Analog and Digital differences

In section 2, the differences between analog and digital recording technologies are compared in different decades. The shift to digital provided new functionality expanded the possibilities for signal processing and drastically changed how and when recordings are edited.

2.1 The differences between analog and digital presented in the 80's:

In analog recording the frequency and dynamic ranges information are stored on right angle axes and are recorded vertically and horizontally without any correlation, in digital recording the information is linear. Because of this digital system can make effective use of limited space. In digital systems signal quality can be sustained easily.

A list of the merits and expectations of the digital recording systems summarized from the standpoint of actual recording operations, (made during 1985):

1. "Recording characteristics are not affected by adjustments of the equipment or the type of the recording medium used".
2. "When digitalized, the change or deterioration of sound quality due to copying is extremely small".
3. "Since digital recording is of high density, effective use is made of the recording medium. As a result, recording area and storage space of the recording medium is economized".
4. "A plurality of information can easily be superposed in a single information channel".
5. "The dynamic range is wide, and crosstalk is low".
6. "Recording and playback time are exact, and synchronous running with other equipment is simple".
7. "Functions can be increased and miniaturization accomplished without impairing basic performance".
8. "By connecting together various facilities with digital transmission lines to form a comprehensive system, an ideal system capable of handling not only sound but all types of information can be constructed".
9. "It can be expected that the cost of equipment and materials will become lower in the future; this will give digital recording an advantage, costwise, over the analog recording. Though the above are merits of digital systems they still cause several problems that require improvement or solving before they can be used fully in practice". [6]

This is an important summary of how professionals may have viewed the digital domain in the mid-80's and also recaps the state of digital recording systems at that time, available functionality, and how well developed the systems were.

In 1985, professionals still used the PCM conversion processor combined with the VCR as the recording device, and another model consist of an open reel type PCM tape recorder employing a dedicated stationary recording head. By that time it had become common to use 44.1 KHz as sample frequency while recording in studios. Kikuta makes a comparison between the open reel system and the PCM Processor with VCR. The PCM processor with VCR seems to be the winner because editing is simpler, and several recorders (VCRs) can be operated with only a single processor. Because of the advantages, it was widely used in recordings for CDs. [6] The open reel system is more based on an analog equipment and the analog way of working. The PCM recorder represented the present and the future.

2.2 Differences between analog equipment and digital equipment and how they work presented in 2001:

First, analog and digital recorders do not sound the same nor do they work in the same way. Analog decks have the ability to reproduce sounds that are reasonably true to the original source, but they add a little warmth to the sound. The warmth results from slight third harmonic distortion, head bumps (bass boost), and tape compression. Analog decks also have the tendency to add some tape hiss, frequency responds errors, wow and flutter, modulation noise and also print-through. [7]

Digital recorders do not have these types of problems, therefore they sound very clean. In fact the authors, B and J Bartlett explain some digital recorders can sound a little harsh compared to the analog recorder, but they are improving with each generation. In particular they continue to write that digital recorders that can record from 24 bits and 96 KHz can sound just as smooth as analog. Both analog and digital have their colorations. So it is preferable to use whatever works artistically for the music being recorded. Compared to analog recorders and open-reel tape, digital recorders and their tape tend to cost less, are smaller, make it easier to locate times on reels and allow easier tape loading. [7]

Digital recording: Like an analog tape deck, a digital recorder puts audio on a magnetic tape, but in a different way. This is the process:

1. "The signal from the mixer is run through a low pass filter (anti-aliasing filter) which removes all frequencies above 20 KHz".
2. "Secondly, the filtered signal is passed through an A/D (analog-to-digital) converter. This converter measures (samples) the voltage of the audio waveform several thousands times a second".
3. "Each time the waveform is measured, a binary number (made of 1's and 0's) is generated that represents the voltage of the waveform at the instant it is measured. This is the process called quantization. Each 1 and 0 represents a bit".
4. "These binary numbers are stored magnetically on tape or disk as a modulated square wave recorded at maximum level".

The playback process is the reverse:

1. "The binary numbers are read from tape".

2. “The D/A (digital-to-analog) converter translate the numbers back into an analog signal made of voltage steps”.
3. “An anti-aliasing filter (low pass filter) smoothes the steps in the analog signal, resulting in the original analog signal”.

The Reed-Solomon error correction corrects most errors. A process called interpolation restores lost data. All digital recording devices employ the same A/D, D/A conversion process, but use different storage media. For instance: a DAT machine records on tape; a hard-disk drive records on magnetic hard disk; a compact disc on an optical disc. The sound quality of any of these devices depends mainly on its A/D and D/A converters. [7]

2.3 Differences between analog and digital and how they work presented in the 80’s.

Kikuta explains that the studio production chain in the 80’s can be divided into 4 parts and he explains differences between analog and digital.

1. In the mid 80’s due to developments of multi-channel recording systems, the recording of original sounds (*tracking*) and the finishing of these sounds into complete music (*mixing*) are considered to be a separate process. The most serious problems concerning digital recording at this time are the trouble due to noise. Though noise is more existing in analog recording, since hiss is a continuous noise it is less noticeable. Regarding sound recording techniques there are no real differences between analog and digital methods and that it can be said that musical sense and policy determine the recorded sound rather than recording techniques. 24 or 32 channels digital system was at this time beginning to be used in multi-channel recorders for the recording of popular music. These recorders are extremely effective in combating the deterioration of the S/N and sound quality caused by dubbing; a problem existing in multi-channel analog recording.

2. *Mixingdown* is the process where the sound that has been recorded is being changed into a work of art; here the producer performs the most important work. The number of inputs on the mixing console should be at least 40 channels. Because of this reason a majority of analog mixing consoles are still being used by the time of 1985. [6]

3. *Editing* consist of rearranging the order of musical parts and adjust sound levels etc. Analog editing used the analog tape recorder, and tape was splicing together in order to compiling parts performed separately or rearranging parts. Cutting and splicing were performed directly on the source material. [6] However it is quite difficult to do so. Analog editing requires skills, to be able to identify musical sync points, to identify performances that could be spliced together seamlessly etc. Miles and Huber explains that the required musical and technical personnel, the performers, the mixing and cutting engineers, have to be assembled together in the same place at the same time. If one does not apply any editing then the whole take to be recorded must be performed right through from the beginning to the end with no mistakes, because the live source is being fed directly to the cutting head. [1]

Digital editing is performed differently in many ways for starters it was not a tape that was cut anymore. One does not need to record a whole song in one take and one can record at different places and then compile parts quite easily. The need for skills is not all as equally important as when editing on analog tapes, because editing can be performed more easy and countless of times. In the 80’s, digital editing on a VCR was time consuming because of the repetition of copying required by electronic editing, this was a disadvantage. To avoid this problem and thus gain work efficiency, a method could be applied where sounds are first

recorded onto magnetic disks and is after that transferred to the master tape after editing. Combining digital and analog sound sources in mixes can create problems in. In particular, different sources require different recording levels, and poor recording technique can cause unpleasant differences between analog and digital sounds. [6] Digital editing today is far more advanced than in the 80's and is not very time consuming as it was then. Computers and the invention of the digital audio workstations (DAW) and signal processing have provided many editing tools that did not exist in the 80's. The editing tools have led to a great deal of convenience and precision. One thing that is certain is that splicing a recording and finding edit points on an analog tape is far more advanced than on a computer because it only requires pushing a button or moving the mouse and right-click. On computers, editors can go back and forth fast, and zoom in, so you know exactly where you should cut. It is clearly far easier to edit, on performing the task physical in the digital computer world, but there is also an aesthetics view on how you should edit or mix that is equally an artful today as it was during analog times.

4. *Mastering*: Mastering analog disks is performed by cutting lacquer disks, but in CD mastering the signals are transferred onto the blank disk inside the digital signal system. [6]

After the mid 80's the equipment moved more away from the analog features and the changes affect on the character of the recorded signal, and digital equipment after the 80's became more advanced. But on the whole the process of the studio production remained unchanged. Nonetheless, the mid 80's were important because of developments made on the multi-channel recording system.

2.4 The quality of digital recording sound presented in the mid-80's:

In the very beginning, the sonic character of digitally recorded sound, particularly distortion in high frequencies, was not considered to be aesthetically pleasing in the recordings. Digital recording systems out of the mid-80's have characteristics that do not exist in the analog recording systems of the time. However, though digital recording includes a few problems concerning dynamic physical characteristics, the performance was enough for practical use. In conventional analog recording, subtle changes in the sound quality occur with every stage in the processing. Nevertheless, though much smaller, changes of a different kind appears also in digital recording. Kikuta's conclusions were that professional digital audio systems of the time never could be called super high fidelity systems. But the sound, once recorded, suffered almost no deterioration when copied or transmitted and a quality like that of the original is maintained. This is a feature that is impossible to attain in analog recording, and the delivery into the hands of the consumer a product of nearly master-grade quality was a very important event.

Kikuta predicted that it was expected that digital recording would continue to spread and expand in many other fields not only in the record industry and that great expectations are held in the future development of digital audio systems and integration with other technology. [6] What he might be talking about here is the computer industry and its components integrating with the audio industries digital recording system in making of other equipments such as interfaces, reverbs, equalizers and such, but also on continuing to build on the equipment already existing.

2.5 Summarized comments about the differences presented in techniques and working methods in 2001 and in the 80's:

First, analog and digital do not work or sound the same. When it comes to how this impacts working methods, there are basic differences just because of the physical differences in equipment. But when it comes to the recording process, when we think in an aesthetic way or in terms of the basic, recording, mix down, mixing, editing processes, there are less obvious changes in function and order. It is what we physically do that has changed the most, not how we think about the process or the process's role in production. Of course, we use different tools when adding digital plug-ins instead of analog effects, the technology or medium does not change our entire approach to production.

3. The Digital revolution

This section deals with the digital revolution the technologies that contributed to it, changes in equipment interfaces, and the growing importance of standardizations in the audio and recording industries. All these components had an affect on studio production and studio roles.

3.1 The Integrated circuit (IC):

The integrated circuit, also known as a "chip", is a miniaturized electronic circuit. The first design was developed in the 1950's. The circuit exists both in audio and video devices. [8] It can be DSP (Digital Signal Processing) chips in the computer that does digital signal processing. They are designed to perform spectral and numerical applications. [9] Miles & Huber explain that the basis of the information and digital age was set when the invention of the integrated circuit was made. The IC has drastically changed the technology and techniques of present-day recording by allowing circuitry to be easily designed and mass produced. They also explain that the three most powerful forces in the "information age" are LSI (Large-scale integrated circuit), mass production and mass-marketing. [1]

3.2 The Computer Technology:

The PC industry itself came first to life with the introduction of hobby computers. This was a commercial success. Apple and IBM were the leading manufactures' at this time. Demand for home and business computers led to higher volumes and advancing technology and made the desktop computer successful. Computing power increased and the product started to drop in price. An important reason why the desktop computer continued to expand and improve was because it generated a large sum of money which was to fund succeeding generations. By the mid-80's the desktop started to take over the mini computers and by the time of the 90's desktops were linked to networked servers with distributed architectures. As the PC market accelerated the demand for increased processing power and lower prices grew. This drove the development of new semiconductors. In conjunction with the drive for lower-cost components came the need for software development tools and operating systems.

As the markets grew, software and hardware companies pushed each other into creating greater product integration. Since the multimedia PCs needed audio processing and conversion they pulled the audio industry into their own industry. The result was both industries expanded and created new technological possibilities. But along the way, this marriage between the audio industry and the computer industry caused things to change in music production – and not all the changes have been for the best. [10]

3.3 The Importance of Standardizations:

The making of standards was to play a major role in the future development of digital audio in our industry. Standards unify an industry along a basic set of convention. This not only helps to make equipment more compatible but helps to educate design engineers, the consumer market and users. Standards have not only helped educate professionals but also made it possible to help the average in-home recorder to hook up gear in the right way and integrate various types of equipment with each other. Standards need to be introduced at the right time to help unify an industry behind developing technical solutions to clearly defined technical challenges.

The importance of standards is mentioned by Lipshitz when he [3] summarizes the digital developments that have happened over the years by writing about all the AES papers that has been produced on digital technology. Setting standards appears to be very important because better results will likely be attained faster if an industry all together more or less focuses on the same issue, rather than everybody focusing on their different specific interests. A speculation is that if we had no standardized equipment, studios would invest in only one system, and the entire recorded product would be made from beginning to end in that one studio. This would be very expensive. There would be less technically possibilities because a whole production would be limited to the functionality of that one system. Standardization is likely to have had a huge impact on all aspects of the music and recording industry - from recording to distribution. It has also made it possible for the recording industry to interface with the computer industry and the communications industry (the Internet and telephone companies).

3.4 Things that made the digital revolution possible:

Several aspects contributed to the digital revolution. Below some points are listed chronologically as likely factors. Their part in changing the production process is noted.

1. The analog technology couldn't be improved further. Something new was needed to make the industry progress technically. This was the starting point for new research.
2. Money for research had to be available, and thus the research and prototypes needed to have its supporters, its investors.
3. Integrated circuits found their way into recording technology.
4. The AES (Audio Engineering Society) helped gathering the audio industry and discuss digital technology. Their conventions educated both users and equipment developers on digital audio and equipment.
5. The AES (Audio Engineering Society) led to standardizations. Standards helped the audio industry to come together and focus on the same developments, and how to make the developments improve. This helped the digital technology to move forward and become better and more stable.
6. The industry of Computer technology; hardware and software integrated with audio, and the audio work station (DAW) eventually was born. DAW are the foundation of nearly every studio these days.

7. Outstanding participants both individuals, Blesser, Lee, Whittaker, Hauser, Nyquist, Schroeder, Logan and several others and companies like Sony, Studer, Mitsubishi, Philips and others [3], dedicating their time to research, develop equipment, tools, methods and help to educate the audio industry and the consumer market. They helped revolutionize the audio industry and made several things possible.
8. Internet & Networks have created the possibility for studios to communicate through computers, sending over material.

The integrated circuit combined with advances in digital technology brought developments of digital equipment and media that affected the ways in which music is produced. “Integrating cost-effective yet powerful production computers with digital mixing systems, modular digital multitracks, MIDI synths/samplers, music-related software, digital signal processors, etc;” gives us the possibility for having a powerful production studio in our homes or in studios. These project and desktop music studios have made it possible for people being able to create and distribute their own music with simplicity, quality and cost-effectiveness. [1]

3.5 Affects of the digital revolution personally presented by an engineer:

These observations were obtained through email correspondence with a blind engineer active in analog studio production. This person explains how the change to digital affected her own work, and what she observed from colleagues. What is learned from this exchange is that with digital technology, equipment and software became visual interfaces, and this caused a problem for visually impaired engineers.

“In the analog world I was quite happy recording and editing classical music for Radio 3 on quarter inch tape but with the transition to digital I could no longer edit because all the interfaces to the editing software were very graphically based. This was annoying since I realized that it wasn't the fact that I couldn't handle digital sound (I had done a masters in music technology and was familiar with Csound and similar synthesis languages, as well as having written an ambisonic sound diffusion package), but that it was simply the design of the interface that was hindering me. In short, the transition from analog to digital recording and editing technologies meant I could no longer do my job so I went to Stanford to try to design an interface for non-textual information (graphs, sound waves, etc.) that might work in situations such as the digital editing suit.

For my colleagues, the situation was obviously somewhat different. Younger folks who had grown up with the start of the PC revolution had little difficulty, but older colleagues found it hard to compress the 3D world of the tape machine and mixing desk into the 2D world of the on-screen editing application. They quickly found that, rather than being the most expert engineers in the field, they were being surpassed by younger folks who quickly grasped the new techniques. Again I believe it was the early design of the interfaces to these programs that caused most of the problems, with deeply layered menu systems and lack of consistency in metaphor across application layers.

It is worth noting that digital recording equipment, such as DATs and hard disc recorders caused fewer problems than the editing software as these had clear functions often assigned to real buttons. Reassignable mixing desk channels did cause people problems for a year or two but were soon assimilated. I would say in summary that many of the teething problems experienced was a result of the design of the early versions of digital recorders, editing software and CD players rather than any intrinsic ability for people to understand the new

technologies. As to whether analog is better than digital - in general I think they both have their advantages and disadvantages but the problems associated with storing and maintaining an analogue archive far outweigh its advantages (assuming some standards are agreed for the universal archiving of digital material.) I think the flexibility of digital systems now that they are more mature, at least for broadcasting, makes them far more practical. Take the example of filing a piece from a remote studio - before you would have to play a recording down a line to a dedicated intake suite played at normal or double speed, now you can simply email an audio file to the producer of a program at their desk in seconds. And you can make multiple backups instantly”.

Graphical interfaces were a problem for analog users who were not used to them or unable to see them. For the engineer herself she explains that the problems were with the graphical interfaces on equipment, which meant she could no longer do her job. The change in the interface was a problem encountered during the transition to digital. For users already familiar with computer interfaces and graphical interfaces the transition to digital recording technology was less difficult. Graphical interfaces also simplified some functionality making parts of the recording process easier for the average engineer. These graphically interfaces and software has made huge differences in how the editing is performed, because of how they are designed. The needs to use our eyes appear to not have been equally of importance in the analog days, as compared to in our digital days. As a conclusion it seems to be that the way of handling analog and digital sound does not differ much, it is rather the way you use, apply and work with it that has been the major changes.

4. The Digital Audio Workstation (DAW):

The digital audio workstation drastically impacted contemporary recording and production. This section describes the new functionality offered in these workstations.

The digital audio workstation which has been widely used for several years includes computers, interfaces, external mixers, soundcards, and software (controls, mixers and additional features). In addition other external digital equipment such as reverbs and equalizers and plug-ins (effects) can be used. This system was seen in most studios starting from the 90's. This system allows recording, editing and mixing audio programs entirely in digital form, providing the highest sound quality. [7] The DAW offers great editing precision through visual interfaces. Monitor screens allow the ability to view sessions and to see what tasks are performed. One downside of this might be that engineers don't use their ears as much as they did before, because of how much they are able to see in visualizations because of digital and computer technology. They get more focused on seeing what we hear sounds well rather than actually listening if it sounds good.

Digital effects can be added through in software and mixdowns can be automated. The soundcard converts audio into computer data that is recorded to the hard-disk. Once the data is stored on the hard-disk it can be read by the reader head there. *Random access* means that the reader head can be controlled to move to any particular location on the disk, and therefore it can get nearly instant access to any given parts of the audio program. Because of this it is easy to locate and edit any part of a session and edit what is to be done. This provides greater work efficiency, and less time is spent to locate particular audio files. [7]

4.1 DAW editing functions:

The following is a list of the common functionality found in the digital audio recording and editing software: *Cut and paste, Copy, Crossfade, fade- in, fade- out, virtual tracks, trim, slip, Time/pitch compression/expansion, automated mixing, spectrum analysis, MIDI sequencer, Number of simultaneous tracks, Locate and marker points, Routing or virtual patchbay, CD recording capability, DSP (Digital Signal Processing), Plug-ins.* [7] These functions were not available in the analog days. They came with the digital revolution, providing with a lot of functions that can be used during sessions or applied after recording sessions during editing. The CD recording capability has made distribution and backups to be made easily.

4.2 DSP (Digital Signal Processing):

Functions provided here include: digital control and effects such as mixing, volume adjustments, panning, surround panning, equalization, reverberation, echo, chorus, limiting, looping, compression, expansion, noise removal and noise gating.

4.3 Plug-ins:

A plug-in is a software module that has the ability to add DSP effects to audio software editing programs. In other words, the plug-in adds sound effects to audio tracks. “Outside” plug-ins that didn’t come with the editing software program can be purchase. These are installed into an editing program - just like standard software upgrades. Common plug-ins are: TDM, VST & DirectX. Different software is available for different operating systems, Windows and Macintosh. [7] The revolutionary caused by plug-ins is that it they are cheap, there are a lot of them and there are developers who specialize in various types of plug-ins creating new ways for music to sound. This ease and diversity created new music genres. Software plug-ins has made it easier for the home recorder to get hold of sound effects, since outboard gear is more expensive. However, these types of programs need a computer that works fast, can store a lot of data, and also has a great deal of memory. The ability to work with fine control audio software programs and being able to take advantage of new functionality has more or less revolutionized the audio industry.

Labelling digital files and recordings in digital production has become a huge issue. There are no longer reels containing all the material for all the tracks in an album. Now there are separate files for each track, sample or part. These get organized in time by software. Being able to put names on each audio file in the digital audio software is also one of those important developments. Keep track of large numbers of audio files is difficult. A common problem is that one particular file of one recorded track or one part does missing or gets moved. As a result, an entire mix may not play properly. Also, digital needs to be backed up. Copies of files must be made because computers can crash, software can fail and data can be lost. Computers are still not entirely trust worthy. Computer viruses are another problem. It has become more and more important to protect you PC from destructive software that can damage the system and files.

These days more and more digital audio software packages can communicate with each other. This allows users to find the best possible combination of several programs. Personal computing has also given the home user access to professional quality studio software. Because of this people are producing at a professionally acceptable quality at home. Mixing consoles and external equipment such as reverbs however is a lot more expensive than software and computers, and is still for the most part found mainly in studios.

5. The Internet, File Transfers & Digital Storage

In section 5, The Internet, transferring files by network and digital storage media are discussed, and what affect they have had on studio production, communications and budgets.

5.1 The Internet & Networks:

The Internet & networks are changing production, but it is not yet clear on how they change every part of the process and what affects they might cause. It is possible to speculate that affect could be on less staff and musicians in the studio and causing budgets to become smaller so session has become shorter. It is however clear that the Internet has caused music to be transferred and distributed quickly and creating new ways to communicate. With networked configurations inside almost every studio one can transfer materials to different workstation and different machines within a studio, and between different studios quickly and cheaply. During sessions musical components can be transferred from home studio to commercial studio; between commercial studios; between collaborators; between recording studios and mastering studio and distributors.

The internet also changes markets. The major issues facing the music industry now is related to the distribution of copyrighted commercial music over the Internet. The Internet is becoming the most preferred way to distribute media, and this trend will certainly continue for both “for fee,” legal and “for free” illegal distribution. [1] Also popular distribution formats like mp3 that compress music so much that the lack of quality becomes an issue for producers and engineers. A conflict could or has already risen on the importance of audio quality.

5.2 P2P:

With the Internet the possibility to share music with others online through P2P (peer-to- peer) applications has radically changed on how we get hold of music. [11] Through p2p, users can give other users permission to download files off their hard drives. These files are created (ripped) from commercially distributed CD's, but can also be from non-released material that has been stolen and distributed illegally. Record companies seem to spend a lot of money on protection of their records to avoid this problem. There is however another possibility which is that consumers through the Internet can improve CD sales by developing markets online and spreading recommendations.

With the Internet and computer technology the possibility to create perfect digital copies and distribute them quickly has become a reality. Copies in the digital domain can be made without loss in audio quality, but also poorer quality copies can be made and distributed even faster and more quickly. Has this resulted in less money being spent making CD's because they will be bootlegged? Is more money being spent on protection of the recording rather than on the recording process itself? DRM (Digital Rights Management) is an anti piracy technology. The intention of this technology and other anti piracy technologies and copy control technologies is to protect CD's from being ripped and distributed. [12] In the “information age” it has become an important issue for music industry to protect investments due to how easy you actually can copy copyrighted material and illegally distribute it.

5.3 Data storage:

First there was the mechanical age, and then the magnetic age where we stored studio sessions on analog mediums like tapes, and then master the music to u-matic tapes which are ¾ inch wide tape video cassettes, [13] and finally we pressed records and made cassettes. These old media have basically died out entirely, with the exception of analog recordings being digitized for distribution, and a small market for LP records. Hard drives are now the recording

medium and CD's and DVD's are the distribution mediums. We also use much of the same media, like CD's, for demos, for masters, and for distribution. Changes in recording and storage media go in hand with changes in the computer hardware industry. More and more data can be stored in smaller, easier, portable formats. Optical discs are more stable and consistent than other mediums such as analog tapes, and they don't get worn out as easily. Analog tapes can get worn out with age and playback, and tape can get damaged easily by moisture, the air and temperature. The sound quality of analog tape degrades with time and use. Discs though also have their problems. They are sensitive to damage, such as scratches, which can cause drop outs. Therefore they need to be handled carefully in order to have a long life. They need to be backed up. However, the quality of the recording remains stable over time and playback.

5.4 The compact disc:

The Compact disc resulted from advances in computers. [14] The compact disc quickly became a replacement for the LP record. Prototypes for what was to become the CD came on mechanical disks, capacitive digital disks and on optical disks. If a common format was to be set some kind of industry unity was needed, otherwise without an agreement this complete new format, the compact disc wasn't going to be supported by the major record companies. It is a necessity to say that all new developments need supporters in order to hit the market and become successful. There needed to be unity and support for both professional and consumer formats. According to Lipshitz it is a credit to the industry and to the partnership of Sony and Philips in particular, that it was possible to get a broad enough commitment from the major parties to agree that a single new format, the compact disc, was to be accepted and released to the public 1982. [3]

The most part of the discussion regarding digital audio occurred only in various technical committees but mostly because a series of international conferences was instituted by the AES started in 1982 regarding digital audio. A couple of conferences continued to take place over the years regarding the same topic. A lot of early digital developments were made in Japan. One important conference was held in Japan in 1985 which focus was on the digital developments made in the country. Papers were written on developments of the rotary-head and stationary-head precursors that were to become the DAT standards in 1984. These developments were intended first to be only for the consumer-market instead for the professional market but because of the delays in its introduction in the West due to the results of fears caused by its ability to make perfect digital copies of copyrighted material, it has turned out to be more seen in the professional audio than in the public. [3]

Perhaps it could be so that the compact disc was the digital thing that was the starting point for digital equipment in the home. It was accessible, relatively inexpensive, high quality. People became interested. Why it became a medium for both the professional and the home user probably lay in the agreement of the professionals and manufactures to have it as a standard and the campaign for it to the mass market. No digital format has had more success than the compact disc.

6. The Analog Recording Chain Vs. The Digital Recording Chain

This section compares the analog recording chain against the digital recording chain to see what has changed, in hardware and what software has done to the chain and production.

6.1 The analog recording chain, versus the digital recording chain in studio production:

All the changes listed above have changed the recording chain in the studio, and the record chain has changed significantly since the introduction of digital technology. These changes have impacted various parts of the process between the signal source and the recorded sound. Most importantly, digital technology has significantly impacted routing signal through out the recording chain, the storage formats used during recording and mastering, and how and when we decide to edit. Digital technology has also introduced new, necessary signal processing and conversions into the recording process.

New things to keep track of have risen since the introduction of digital technology. In sessions now engineers need to observe where sessions are stored on the hard drive, and to make sure all files are in the same location. Backups need to be made. There are more automated tasks, but the computer and the recording software need to be configured.

The following chart highlights some important changes

Analog	Digital
Preamps/Conversion:	
We have the analog console with preamps and an EQ part. These two components are widely used for tracking to tape. We also have functions like pan pots on the console. No conversion steps here, the signal is always analog.	We have a PC, an interface with preamps, and d/a converter and several different standard inputs on it. More inputs here then on an analog console. Because of all the different standardized inputs, the interface integrates with a lot of different equipment. You can use the interface a/d converter, but you can also patch in others.
Recording Quality:	
Instruments are recorded at the highest possible quality. Every attempt is made to preserve that quality through mixing and mastering, but the consumer product is of lower quality.	In digital, we can record at different sample rates, but not too low due to noise. We can perform “upsampling” and “down sampling” at every stage of production - but with potential loss of quality!; For example, we can record in 16 bit but mix on 24 bit, this however can lead to an audible change in quality.
Patching/Routing:	
Physical patching and routing all equipment in the patchbay with cables. All equipment goes through this patchbay.	Both physical patching and virtual routing. Virtual routings can be stored on equipment or on software made for this purpose.
Plugins:	
The plugins here are all hardware and need to be physically patched in the patchbay.	Both hardware and software plugins.
Source signal:	
The source signal is always analog both input and output.	There are digital and analog sources. When, the source signal is analog, you need an A/D converter for the signal to be digital. And finally a D/A converter in order for the music to be acoustic/analog again. More inputs are provided for other equipment.
Storing:	
Recordings are stored on tapes. Does not have the same storing capacity as a hard drive. It is a	Recordings are stored on computer hard drives. A lot can be stored, several gigs. A necessity is to

fragile medium that degrades over time and number of playbacks	have a lot of space available, and a fast processor. No risk of loss of high end, loss of quality over time, in digital.
Editing:	
Editing; splicing tapes; cue and mark points, then cut, fade in fade outs can't be done. The tape loses quality in strength when cutting. It is a lot harder to edit, and producers are most likely to finish the entire recordings/albums before editing.	Editing is being done digitally on computers in the recording production software. Editing can be done quickly, even during sessions, and basically whenever you want to. Cut and paste things goes in a second. Overdubs are easy to do. More editing functions are provided here in the digital world.
Mastering:	
Analog mastering had its own professional quality media. Music is transferred to u-matic tapes. From u-matic to cassette, vinyl, CD's etc.	Digital mastering. The production medium and the final deliverable medium is basically the same format, but can be changed instant on the same computer. The "master" can easily be transferred over networks, onto CD's, DVD's. There is no need for difference between the production media and the consumer media. This was the case before.

7. Societies Impact on the Production and the Recording Chain:

Society, meaning consumers at large, have had an impact on the development and adoption of new recording technologies. The availability of inexpensive, home recording equipment has created competition for commercial studios, and caused a re-evaluation of the production process and what is recorded at home versus in the commercial studio and by whom. The growing market for home recording equipment is shifting the audio industry's attention away from products for commercial studios, and changing expectations about audio quality. Section 7 reviews how these developments change the production process, roles of the producer and engineer and recording technology.

Blessner & Pilkington discuss the fact that society is getting more involved in the process of developing new technologies. What the mass market wants may not be what professionals want, so a conflict rises. They state that it is important to understand that many of the commoditized technologies that we rely and depend on emerge from, and are supported by the mass market. [10] So early on, in the digital era professionals in the audio industry were more involved in technical developments. Professionals made technologies for other professionals, because they were the only ones who knew how to handle the new technology. As digital technology has become more and more popular to the mass market and been integrated with the computer industry and people got more educated about digital, far more people have obtained the knowledge to use the equipment and about how the technology works. As a result of that there are many home studios and relatively cheap recording production software and hardware. Therefore, the audio industry and its professional have lost some of their power.

These days society in general has much more influence on what products are being made. This is mainly because now non-professionals are the mass consumer. Products with few consumers or with few interests won't get built or developed, since there isn't that much money to make. While there is companies that only focus on making professional products for

the professional studio, these markets are small, and won't be able to expand. [10] Audio quality is also important to the mass market, and not only the professional, but how important? Are consumers willing to give up the audio quality for cheaper products, for convenience? This is not something that professionals would do. Audio quality has not managed to prevent a revolution in lower quality, lower priced technology that is convenient or new methods of distribution like the Internet. This helps put many music studios out of business.

The audio industry has never entirely been capable of alone driving itself ahead. It is too small to invent everything on its own. [10] It is supported and depended on other huge influential industries like the computer industry which creates new uses for audio technology and develops new audio relevant technologies, and the music industry that promotes music production and new recordings. Maybe this dependence has become stronger and today the audio industry is even more depended on other industries to drive it ahead. So the mass market impacts what technology we see in the studio causing them to have an impact on how the producers and engineers work. The home studio, dropping costs of production tools, and a lessening of quality for convenience also impacts the producers and the engineers work. Maybe all of this is causing a decrease in jobs and fewer opportunities for the professionals.

8. The Music Industries Impact on the Changes in Studio Production:

Recording budgets are decreasing, and at the same time the Major labels control a dominant percentage of the market. This section looks at some of the reasons for decreases in recording budgets and the impact on the types of music produced.

Over the past few decades there have been many changes in the Music Industries; some of the changes discussed below have impacted studio production. Throughout recording history the music industry's part has been to make recorded music profitable. The commercial advertising and distribution of recorded music is definitely the greatest economic motivating factor driving both the audio and recording industries. As a result, changes in the sales of recordings lead to changes in the adoption of technology and also to the development and studio production. One thought is that since big, Major labels control most of the market we have a lot of what we call "mainstream" music. There are independent labels, but Major labels basically still control what music is recorded and distributed. In the global music market in 2005, shares controlled by Major labels were as follows according to IFPI (International Federation of the Phonographic Industry) [12]:

Control of Market Share (in percentages)				
Universal 25.5%	Sony/BMG 21.5%	EMI 13.4%	Warner 11.3%	Independent labels 28.4%

The size and influence of the independent music market fluctuates. What are the problems with having four global, major labels? The reason, in part, why they are so big is because they are part of bigger companies that have investments in industries like electronics and the movie industry. Because of that, they control a lot of money, power and influence. The music parts of these big companies keep growing stronger and taking over smaller, independent labels. It has indeed become cheaper and easier for both Majors and Independents to distribute recorded music. The Internet has provided many new marketing and distribution possibilities. Because of this Independent labels have found new ways to get their music out to listeners, and it is easier to create your own label than it was ever before. The Internet has played an important part in keeping the market up for independent music. The Internet has a positive

affect for small, unknown artists by helping making it possible to distribute independent music. But the Majors still have a powerful control on music distribution. Most importantly, they have marketing budgets that very few independent labels can compete with. In some ways, the small labels invest less and have less to lose compared to majors. The power and influence that the large companies have is guaranteeing that their product will be marketed to the widest possible audience, and has the best possible positioning in broadcast media. Independent labels can not compete with that. The “expansion” comes from the fact that the recording companies are now part of huge media, publishing, and entertainment companies. These major companies then control the largest film studios, newspapers, book publishers, radio etc. This provides them with more and more ways to market and more and more ways to place music in movies and other venues.

There are questions whether CD sales have actually declined or not globally. Different suggestions are likely to come from different directions. However, it is hard to find up-to-date and “accurate” numbers of CD sales worldwide because some research and statistics are available only for pay from market analysts, and also the music industry has an interest in leaving some question about whether sales have gone down, up or are left unchanged. The discussion here is therefore left open on whether sales have increased or decreased. However The RIAA (Recording Industry Association of America) reports that physical CD sales in 2005 compared to 2004 have declined in the US. They also report that physical CD singles sales dramatically declined in percentage in 2004 compared to in 2003 and continued to decline in 2005 in the US market. Digital sales in downloads for both singles and CD’s in 2005 have dramatically increased in percentage in the US. The RIAA continues to report that since 2004 digital sales have increased more than physical ones in the US. [15] Speculations here are therefore that this is not only a trend in the US but a global one, that physical sales goes down and digital ones goes up.

In 2004 physical CD’s sold through Internet sites increased fast giving the numbers of 15% in Germany, 10% in the UK and 6% in USA. The internet was the fastest growing retail business that year. Also in 2004, 180 new legal download sites were born, giving a total of over 300 sites, where 200 are to exist in Europe. In 2005 digital sales continued to grow. The invention of the 3G mobile phone and the service by major operators has made it possible to download music directly to the phone, which IFPI states has given it boost to the download music market. [12] Despite the growing digital and Internet sales, the Music Industry fears it is losing profits.

IFPI states that every third CD sold world wide is an illegal copy and that this impacts jobs and kills investments. They expect that the total sum of money the piracy market makes is US\$4.6 billion. In 2004, 34% of the world wide CD sales were piracy copies. However IFPI explains that piracy sales have slowed down some from 2002-2004, compared to the major increase from 2000-2002 and that this partly due to better control of markets in Mexico, Spain, Paraguay, Brazil and Hong Kong. [16] If we look past the fact of CD sales having increase, decreased or remained unchanged globally, it is however clear that money is being lost due to the piracy industry. Regardless of the actual numbers, the music industry perceives that its product is threatened and this has impacted recording budgets. Therefore, financial changes effect studio production and the jobs for the producer and the engineer, giving them less pay, and perhaps also fewer jobs. These speculations seem likely, but as we are currently experiencing these changes we do not have the perspective to identify the reasons for the changes. Through studies like this one, however, we may be better able to tie cause to effect, and better shape how both the music and the recording industry move forward.

How will the majors remain strong, what do they need to do? The answer to that question might be to look even harder at their investments, trying to legalize the entire download industry on the Internet, or make sure that CD's become cheaper. The major labels are probably going to continue to expand, but at what price to musical diversity? If that happens it might lead all music to be "mainstream" in the future and that some genres will cease to exist, or at least become even smaller than they were from the beginning. How does all of this then impact studio production? What happens to the artistic approach to recording? Recording Budgets seem to be getting smaller and smaller possibly because of competition with other global media industries like the movie industry or the game industry or the piracy industry. If there are in fact globally dropping CD sales then this could be another potential factor. Lower recording budgets impact studio production because they cause smaller budgets for producers and engineers in production restricting their chance to explore new creative possibilities, the equipment they are able to have, and the people they can hire in the studio. The majors control what music is being recorded.

9. The changing of roles and studio work since the 70's:

This is a small survey of what roles existed in the 70's in the average American studio and how it has changed since digital was introduced.

Staff in the analog studio [17]:

- The engineer
- The recording director
- Console Operator
- Mixdown mixer
- Disc recordist
- Maintenance engineer
- Duplicating engineer
- Dubbing mixer

The basic changes:

The recording director becomes the Producer. The basic tasks and responsibilities that he or she had before is still applied today.

All these "little roles" that Morris presents, like the disc recordist, the mixdown mixer or the dubbing mixer gets all absorbed by the engineer.

The role of the maintenance engineer the one who make sure the equipment is working as it should is still needed, but they these days spend more time on formatting hard drives than say calibrating tape heads.

The tape operator gets replaced by the pro tools, or hard disk recorder, operator.

Some functions that the human being used to do have been replaced by technology like no splice tapes anymore, we tell the software what to edit, and then it does what it's asked. There were more specialized roles before. Now one person must be good at many tasks/skills. Also, the role of the engineer and the producer is merging, probably since the increase in home studios. We see a trend that a lot of people that started out as engineers also produce these days. With digital hardware and software it has become a lot easier to do all the work

yourself. Mixing has become a specialty and some engineers and producers have turned to mixing specifically. Maybe because there are so many of them they need to become more specialized to find work. Project length has decreases with budgets. So, engineers and producers are in need to find work more often than before.

10. The Experiment:

Section 10 describes the experiment, the questionnaire and subject responses, and provides an analysis of the data collected.

To investigate the changes in the roles of producers and engineers several professionals were questioned via questionnaire about their jobs before and after the introduction of digital recording technology. The experiment is meant to compliment the literature study, providing perhaps additional information and indications on changes. The responses indicate which aspects of these jobs have changed and why, and suggest future trends for recording practices. While this study only includes a small number of subjects, the perspectives represented cover several genres, working approaches and levels of professional experience. Because of those reason the analysis will be approached with caution. It is relevant to mention that if the majority of the participants agree or disagree on something then that is taken for an indication of change or for reality. However, these are taken to be good areas for further, deeper research rather than a comprehensive and representative study of the recording industry as a whole. In this way, teasing apart this complex problem is approaches systematically.

The experiment that follows involves questions on how the studio production has changes since the adoption of digital, but also through outside industries having an impact. The procedure was to e-mail questionnaires to participants who emailed back their responses. No time limit was enforced on how long subjects had to write their responses. The questions were chosen based on findings from the literature survey with the hope they would reveal in what parts in the production chain changes have occurred regarding technology, role changing, preferences for analog and digital, how much time spent on different tasks and whether the conversions with parties involved in the making of recordings have changed. The questions target areas that seemed to be the most important points of change. All together a total of 7 people from Sweden, the UK and the US participated including three producers who have been active from 30 to 10 years and four engineers who have been active from 30 to 22 years. The following charts describe each participant's years of experience and country.

Producers		
Participant	Years active in production	Country
1	13 years	Sweden
2	30 years	Sweden
3	10 years	UK and Sweden

Engineers		
Participant	Years active in production	Country
1	18 years	US
2	30 years	US
3	25 years	Sweden
4	22 years	Sweden

10.1 The questions asked for both the producers and the engineers:

Analysis of the questionnaire is used to verify if studio production indeed has changed and if so in what parts of the production chain. Also, the questions attempt to investigate if this could have happened because of changes in technology, and/or the possible impact of other industries on studio production and the work for the producers and the engineers. Had communications changed because of new technology? Where there now new things that needed to be considered and discussed to get the best performance or product out? It was necessary to ask how they adapted to technical change.

It was also important to ask if they noticed smaller budgets existing these days and if so did it then in then may have affected the recording process in a negative way. Have negotiations with companies/labels become trickier because of the possibility on change into to fewer budgets? Could the changes that likely happened in the studio production because of changes in other industries affected on the number of how many jobs there are available these days? What was expected was to see indications on changes happening and to reflect on them. Since there were far too less participants it was clear not too many conclusions was possible to obtain. The questions were designed to get the subjects to reflect on how much time they spent on various parts of the production processes before and after the change to digital. Also, they were intended to uncover if producers and engineers emphasized different topics or things in their conversations with collaborators since the introduction of digital. This would be an indicator of a shift in priorities. Lastly, the questions help to uncover if there is a preference for analog or digital equipment.

10.2 The Questionnaire:

Questions specific for the producers only are marked with (**Producer**) and questions specific for the engineers only are marked with (**Engineer**). Answers of the questionnaire can be found in the appendix after the paper. Question nr 1 to 6 was asked to both the producers and the engineers and will therefore not be included here on the questionnaire for the engineers. After the questionnaires comment on the questions asked and important findings will be provided.

The questionnaire for the producers:

1. How long (in years) have you been producing music?
2. Do you produce major label artists or independent artists or both?
3. What genres or styles of music do you record?
4. Do you believe that the computer technology have changed the way we record music today? Yes or No?

If you want to explain your answer, please write your comments here:

5. The following questions deal with your preferences for analog and digital. Please answer using the following statements “always analog” “sometimes analog” or “never analog” or “always digital” etc. Please give a short explanation of why in each case (for example, ease of use, aesthetics, etc.) You can say both analog and digital, but please explain when and why for each.
 - 5a. Do you prefer analog or digital for recording instruments?
 - 5b. Do you prefer analog or digital for recording vocals?
 - 5c. Do you prefer analog or digital for mixing?
 - 5d. Do you prefer analog or digital for mastering?
6. On average, has the total length of time for recording projects (from pre-production through final product) increased or decreased since the introduction of digital technology?

The following questions ask how much time, on average, you spend on various aspects of a project. Please answer using “more”, “less”, “same” to indicate if you spend more, less or the same time since the change to digital. If it is not applicable to how you run sessions please write “not applicable”.

7. **(Producer)** In negotiations with record companies/labels? (“more”, “less”, “same” or “not applicable”)
8. In pre-production?
9. **(Producer)** Rehearsing with musicians?
10. **(Producer)** Talking and planning with artists regarding sound, aesthetic approach, etc.
11. **(Producer)** Talking and planning with the engineer?
12. Tracking/recording vocals and instruments?
13. **(Producer)** Communicating with performers about performances during recording sessions? (“more”, “less”, “same” or “not applicable”)
14. Editing (“more”, “less”, “same” or “not applicable”)
15. Mixing (“more”, “less”, “same” or “not applicable”)

Have the people present in mixing sessions changed since the change to digital? If yes, who was there before and after?

(Producer) Has what you talk about to the engineer during mixing sessions changed? If so how?

16. Mastering (“more”, “less”, “same”, or “not applicable”)

17. Do the choices of music consumers directly affect what types of projects you work on and how you work in the studio? If yes, how, in what ways? Has that changed since the adoption of digital?

The following questions relate to how the music industry (i.e. Major Record Companies) affects Studio production.

18. Are you able to work with less established artists or develop new artists more or less since the change to digital?

19. **(Producer)** On average are your budgets larger or smaller?

20. **(Producer)** Is more or less money budgeted for time to develop a unique sound for artists/projects?

21. Do you spend more or less time developing a unique sound for artists/projects?

The following questions relate to non-sound recording technologies.

22. Has Internet technology (other than P2P file sharing) affected music production? Yes or No

If you want to explain your answer, please write your comments here:

23. **(Producer)** Has P2P file sharing impacted budgets? Yes or No

If you want to explain your answer, please write your comments here:

24. Has the dropping costs of production tools and increased in home recording impacted your job? Yes or No

If you want to explain your answer, please write your comments here:

25. **(Producer)** Are there more or fewer music producers today? More or Less

If you want to explain your answer, please write your comments here:

26. Has the number of personnel in the average recording session increased or decreased in studios over the years?

27. What roles have been added or removed?

28. **(Producer)** Do you see the role of the producer in the record production changing since the adoption of digital technology? Yes or No

If you want to explain your answer, please write your comments here:

29. Do you see the role of the producer and engineer merging? Yes or No?

If yes, how?

The questionnaire for the engineers starting with question nr 7:

The following questions ask how much time, on average, you spend on various aspects of a project. Please answer using “more”, “less”, “same” to indicate if you spend more, less or the same time since the change to digital. If it is not applicable to how you run sessions please write “not applicable”.

7. In pre-production?

8. **(Engineer)** Talking and planning with producer regarding technical issues such as equipment monitoring etc?

9. **(Engineer)** Talking and planning with producer regarding aesthetic approach?

10. **(Engineer)** How much in studio time do you spent setting up a session?

11. Tracking/recording vocals and instruments?

12. **(Engineer)** Communicating with musicians during recording sessions? (“more”, “less”, “same” or “not applicable”).

Has what you talk about changed? If so how?

13. **(Engineer)** Communicating with producer during the recording sessions? (“more”, “less”, “same” or “not applicable”).

14. Editing (“more”, “less”, “same” or “not applicable”)

15. Mixing (“more”, “less”, “same” or “not applicable”)

Have the people present in mixing sessions changed since the change to digital? If yes, who was there before and after?

(Engineer) Has what you talk about to the producer during mixing sessions changed? If so how?

16. Mastering (“more”, “less”, “same”, or “not applicable”)

17. Do the choices of music consumers directly affect what types of projects you work on and how you work in the studio? If yes, how, in what ways? Has that changed since the adoption of digital?

18. Are you able to work with less established artists or develop new artists more or less since the change to digital?

19. Do you spend more or less time developing a unique sound for artists/projects?

The following questions relate to non-sound recording technologies.

20. Has Internet technology (other than P2P file sharing) affected music production? Yes or No

If you want to explain your answer, please write your comments here:

21. **(Engineer)** Has P2P file sharing impacted engineers' salaries or the number of available jobs? Yes or No

If you want to explain your answer, please write your comments here:

22. Has the dropping costs of production tools and increased in home recording impacted your job? Yes or No

If you want to explain your answer, please write your comments here:

23. **(Engineer)** Are there more or fewer recording engineers today? More or Less

If you want to explain your answer, please write your comments here:

24. Has the number of personnel in the average recording session increased or decreased in studios over the years?

25. What roles have been added or removed?

26. **(Engineer)** Do you see the role of the engineer in the recording production changing since the adoption of digital?

If you want to explain your answer, please write your comments here:

27. Do you see the role of the producer and engineer merging? Yes or No?

If yes, how?

10.3 Important findings of the questionnaire producers

The following sections only highlight the interesting findings from the data analysis.

Therefore not all questions and answers are brought up. A complete set of responses can be found in the appendix.

Question nr4 producers: Do you believe that the computer technology changed the way we record music today?

The data revealed that all participants agree on that computer technology has indeed changed on how it is being done. Indications are therefore that this is has happened.

Question nr 6 producers: On average, has the total length of time for recording projects (from pre-production through final product) increased or decreased since the intro of digital technology?

Two out of three participants answered that the total length of time has in fact *increased*. This could mean that since digital technology is a complex tool and leaves you with many

opportunities and options this is the facts why two people agree on the change. The third person answered that it hasn't been any real change. No one answered that it has decreased.

Question nr7 producers: Same type of time question as the previous one, but on pre-production. The result: 1: more, 2: same, 3: same.

Answers indicate on no major change. The processes that fall into, under the category of pre-production like planning and setting up sessions seem to be almost as time consuming as before.

Question nr11 producers: Same type of time question as before but on talking and planning with the engineer? The result: 1: more, 2: more, 3: same

No one answered that less time is spent. Indications given by the answers would be that the producer has more to talk about with the engineers, not necessarily meaning on only technical matters. Here personal matter and the size of the session come into play.

Question nr12 producers: Same as before but on tracking/recording vocals and instruments? The result: 1. Basic tracking; more. Overdubs: less. 2. More 3. Same

Different answers obtained, hard to see any indications. Participant 1's answer that there is more basic tracking being done, and less overdubs being done might indicate some possible changes on this part of the production.

Question nr14 producers: Same type of time question as the previous one, but on editing. The result: 1. More 2. More 3. Same, but different.

Indications of the data reveals that more time is spent on editing as supposed to before in the analog days.

Question nr15 producers: Same as above, but on mixing? The result: 1. Same 2. More 3. Did not answer

Different answers obtained, difficult to see any indications other than that there is no *less* time spent. It depends a lot on personal basis and the size of the session.

Have the people present in sessions changed since the change to digital? If yes, who was there before and after? 1. "Not in the way I work" 2. No 3. No

Indications suggest that there is no change. Personal matter comes into play here as well.

Has what you talk about with the engineer during mixing sessions changed? If so, how? The result: 1. Yes, in the way of choosing plug-ins rather than using outboards. 2. Not applicable 3. Not really.

No real indications can be said. Given by participant 1 answer, maybe a possible change is in hardware to software.

Question nr17 producers: Do the choices of music consumers directly affect what types of projects you work on and how you work on in the studio? If yes, how, in what way?

The result: 1. Not really 2. No 3. No

Indications suggest music consumers possible affect does not come into play here.

Question nr18 producers: Are you able to work with less established artists or develop new artists more or less since the change to digital?

1. Absolutely more; it's cheaper; therefore there are more "small" sessions. 2. Same 3. Yes

Indications suggest that there is a possibility to work more with these types of artists since the adoption of digital.

Question nr19 producers: On average are your budgets larger or smaller?

1. Much smaller since 2001; But not necessarily due to digital. 2. Smaller 3. Smaller

Indications suggest that there are on average smaller budgets, these days.

Question nr20 producers: Is more or less money budgeted for time to develop a unique sound for artists/projects?

1. Less 2. Less 3. Less

Indications suggest that there are *less money budgeted*.

Question nr21 producers: Do you spend more or less time developing a unique sound for artists/projects?

1. About the same; "I feel you have to give each artist a unique sound". 2. More 3. The same amount

Indications suggest that either more or the same amount of time is spent.

Question nr22 producers: Has Internet technology (other than P2P file sharing) affected music production? The result: 1. No; not in the way I see it. 2. Yes 3. No; "A little".

Different answers are obtained. Hard to see any indications, but participant 1 adds "I think that the overall climate regarding the entertainment industries has changed. Music has a lot more competition from games, film, sports." Participant 1 seems to suggest that other entertainment industries have affected and changed studio production changing, not internet technology.

Question nr23 producers: Has P2P file sharing impacted budgets?

1. Yes; Absolutely 2. Did not answer 3. No; "That's just propaganda from the Major labels!"

Different answers obtained, hard to see any indications.

Question nr24 producers: Has the dropping costs of production tools and increased in home recordings impacted your job? 1. Yes 2. Yes 3. Yes

Indications suggest that this reality. Participant 2 explained that you can't take the same amount of money on mixing jobs, as compared to before, and this being the reason.

Question nr25 producers: Are there more or fewer music producers today?

1. A lot more 2. Probably more 3. Far too many!

Indications suggest on more.

Question nr26 producers: Has the number of personnel in the average recording session increased or decreased in studios over the years? 1. Decreased 2. In my case, no difference 3. It depends

Indications suggest that it has either decreased or that there has been no change. It also seems to depend.

Question nr27 producers: What roles have been added or removed?

1. Removed: Tape operator, second engineer 2. No difference 3. Added: Programming, ProTools editing, and system operator.

Indications suggest that the role of the tape operator has been removed, and that the second engineers is started to be removed. Indications that roles haven been added, and possible replace others are obtained. Participant 2 explained that he takes on the role that is the demanded on him for the project.

Question nr28 producers: Do you see the role of the producer changing since the adoption of digital? 1 Yes; A lot more song writers also become producers. 2. Did not answer; I can only see it from my point of View and digital technology had nothing to do with it". 3. Yes

Indications suggest that the role of the producer has changed, but not necessarily because of digital technology.

Question nr29 producers: Do you see the role of the producer and engineer emerging?

1. Yes 2. "For me it's always been a shared interest for the technical and the musical, and through the years I've realized that it is the musical side that always is the most important one". 3. it's already happen.

Indications suggest that the role of the producer and engineer is emerging.

10.4 Important findings of the engineer questionnaire:

Question nr4 engineers: Do you believe that the computer technology changed the way we record music today? The result: 1. Yes 2. Yes 3. Yes 4. Yes.

Indications suggest that this has happened. All the participants agree on the exact same thing as the producers. Participant 1 added: "The largest effect of computers on music falls into two areas". "... We have much more powerful tools to create music. The secondary effect of computers and technology in general is a radical shift in the decision making process". "Nowadays decisions are made much later in the production process".

Two participated engineers speak of that decision are held much later in the process. Indications therefore also suggest that this is the case.

Question nr 6 engineers: On average, has the total length of time for recording projects (from pre-production through final product) increased or decreased since the intro of digital technology?

The result: 1. given by the participant answer; it has increased. 2. "It hasn't changed the time frame at all". 3. "About the same as before". 4. Increased.

Indications suggest that either it has increased or the same amount of time is spent. Why the answers differ is probably based a lot on a personal basis and on how they actually work. Indications also suggest given by participant 1 and 4 comments, that you are able to do detailed work and that has increased the time frame. Same answers are obtained from both the producers and engineers. It's either that it has increased or that there have been no time changes.

Question nr7 engineers: Same type of time question as the previous one, but on pre-production. The result: 1: not applicable, 2: same, 3: more, 4: more.

Indications suggest that more time is spent, but difficult to make conclusions since the answers differ a little, and because for one person it was not applicable. This again would depend a lot on each of the engineers' personal working. No, less time is spent. We see the same pattern between the producers and engineers; it's either the "same" amount spent or it is "more" time spent.

Question nr12 engineers: Same as before but on communicating with musicians during sessions? The result: 1. Same. 2. Same. 3. Less. 4. Same

Indications suggest that the same amount of time is spent.

Has what you talked about changed? If so how? 1. "Yes, musicians are much more involved in the production process than in the past. 2. "Yes, DSD or PCM in regard to PCM bit depth & sample rate". 3. Yes. We talk more about details

Indications suggest that what they talk about has changed.

Question nr14 engineers: Same type of time question as nr 6, but on editing? 1. More 2. Less 3. Did not answer 4. More

Indications suggest that more time is spent on editing, but since one person did not answer no real conclusion can be made. Participant 1 added: "Editing has increased exponentially. In the past, a classical record with 50 minutes of music would have 100-150 edits. Now the norm is for 300+". This depends a lot on personal basis.

For both the producers and engineers the most common answer is "more". More time editing is spent.

Question nr15 engineers: Same as above, but on mixing? The result: 1. More 2. More 3. More 4. More

Indications suggest that more time is spent on mixing. Participant 1 leaved the following comment: "The available technology has opened many options to make changes, and these changes slow down the process greatly".

Have the people present in sessions changed since the change to digital? If yes, who was there before and after? 1. Yes and no. "In the past there was the tape operator. They have been replaced by the ProTools operator". 2. Yes "Always a (box operator) ProTools, DP etc 3. No 4. No

We see here indications on an important replacement, because of new technology.

Question nr16 engineers: Same type of question as nr 6 but on mastering

The result: 1. “The mastering session has gone from 10-12 hours as the norm to 6- 8” 2. Answered “yes”. 3. Answered “no”. 4. Answered “no”.

Indications suggest that there is a tie. No conclusions can be made.

The engineer that answered that more time is spent on mastering sessions contradicts what the producers are saying and what two engineers are saying. Could the reply here be based on personal experience or is it a general view?

Question nr17 engineers: Do the choices of music consumers directly affect what types of projects you work on and how you work on in the studio? If yes, how, in what way?

The result: 1. “No, we are trying to make the best possible product, regardless of the delivery medium” 2. Yes. “Now you may think about a quick track to download”. 3. No. 4. No

Indications suggest that music consumers possible affect does not come into play here. In comparison with the producers’ indications suggest that music consumers have no affect here.

Question nr18 engineers: Are you able to work with less established artists or develop new artists more or less since the change to digital? The result: 1. Less 2. More 3. Yes 4. Did not answer

Different answers are obtained, no indications can be made. Participant 1’s comment is of importance: “The large companies no longer develop new artists’ careers, they release records. The norm is for unsigned artists to do a complete record and then shop for a label, rather than the other way around”. What the producer 1 is saying compared to what engineer 1 is saying, is two interesting ways to look at the situation.

Question nr 20 engineers: Has Internet technology (other than P2P file sharing) affected music production? 1. Yes; “It is very common for the delivery of materials for mastering to come over the FTP server”. 2. Yes 3. No 4. Yes

Indications suggest that this is reality. The engineers were here more agree on this question when 3 participants out of 4 answering “yes” than the producers where one said “yes” and the others said “no”, but producer participant 3 “a little”.

Question nr21 engineers: Has P2P file sharing impacted engineers’ salaries or the number of available jobs? 1. Yes; “The money to pay for records has to come from somewhere. If you cannot sell you product because of theft, it is difficult to stay in business. Unfortunately the technology is ahead of morality”.

2. Yes; “In general the whole paradigm of the assistant engineer has shifted, there are not many large studio jobs available”.

3. No 4. No opinion

Indications suggest on that there has been an impact, but since one participant stated “no opinion”, no conclusions can be made.

Question nr22 engineers: Has the dropping costs of production tools and increased in home recordings impacted your job? 1. Yes 2. Yes; we charged more for our services in 1988 than we do today. The access to technology is the direct cause". 3. No 4. Yes; "Bad engineered home recordings needs to be imported to the real session".

Indications suggest that this is happening. Both producers and engineer answers indicates on this.

Question nr23 engineers: Are there more or fewer recording engineers today?

1. "There are more people recording, but far fewer engineers". "The training of engineers and the need for technical skills has dropped significantly in the computer age". 2. "Less engineers, more (Box operators), people that just edit or rum the (Box) during tracking". 3. Less 4. Less; "Less craftsmen - more self taught".

Indications suggest that there are fewer engineers.
Compared to the producers the answers differ completely.

Question nr 24 engineers: Has the number of personnel in the average recording session increased or decreased in studios over the years? 1. Basically the same 2. Decreased 3. Decreased 4. No change

Indications suggest that the number has decreased, or that there has been no change into fewer people. This of course depends on the size of the studio and how many personnel are required. Compared to the producers' answers here it gave indications.

Question nr25 engineers: What roles have been added or removed?

1. "The tape operator has been replaced by the ProTools operator". 2. "Less second engineers". 3. "Less musicians". 4. "Sometimes one person alone only runs the DAWs".

Here it indicates that roles have been added, but it is more of a replacement matter because of new technology. Roles gets removed but are replaced with others. The producers' results basically indicate on the same thing.

Question nr26 engineers: Do you see the role of the engineer in the recording production changing since the adoption of digital? 1. Not really. 2. Yes; "We have become more involved in "production". 3. Yes 4. Yes; "The artists need the engineer to create their performance on a record".

Indications suggest that the role of the recording engineer have changed since the adoption of digital. Same indications are also obtained here compared to the producers.

Question nr27 engineers: Do you see the role of the engineer and the producer merging? If yes how? 1. "This happened about 30 years ago with the move from the record company studio to the private studio". 2. Yes; less producer only people, most often now the artist is the producer so he's in the studio playing". 3. No 4. No

Indications suggest there is a tie. Peculiar that participant one answered that this has already happened 30 years ago, while two other participants answered "no". Could it be that for those who answered "no", there has not been a change for them personally? Compared to the producers it is not as clear for them on "yes".

10.5 Analysis of questionnaires:

The participant producers and engineers both agree and disagree on the questions given. The reasons for this could be personal experience but of course own point of views. It should be stated that the engineer have all been far more active in the production compared to the producers. This could mean something. Since the result here only represent a few point of views this is does not represent a general view.

On computer technology: Probably the most important finding, is the fact that all participants in both categories agree on that computer technology has indeed changed the way we record music today.

Changes indicate to have happened both on *pre production* and *post production*, but also on *role changing*; roles gets replaced by others, like the *tape operator* that played an important part has now been replaced by the *Pro tools operator*.

Indications that *budgets* have become smaller compared to in the analog days are obtained from the questionnaire. Indications that less money is budgeted for developing a unique sound for artists/projects are obtained too.

On pre-production, the data indicates that there is either more time spent or the same amount spent in the digital domain as supposed to in the analog. Two producers answered that the *same* amount of time is spent and one answered *more*. The engineers gave the opposite answers here two answered *more* and one answered the *same*. The fourth answered “not applicable”. So indications tells us that a small change might have occurred, revealing that more time might be spent these days on pre production.

On post- production: editing; indications of the result tells us that a change into more time being spent is clearer here as opposed to the result on pre production. More time seems to be spent on editing in the digital domain compared to the analog.

When it comes to *mixing* all the engineers answered that “*more*” time is spent compared to the producers, where one person said “*more*” and another said the “*same*”, and the third person did not answer. By the result it indicates that the engineers have experienced more change than the producers, maybe this is because they have spent more years working. But since one producer did not answer and that the participated numbers aren’t even, no conclusions can be made.

On average length of time from pre production through final product, indications obtained from the producers result tell us that the time has increased since the introduction of digital. One participant explained that there are fewer budgets from labels. Indications from the engineers result states that there has either increased or that the same amount of time is spent. Here the participants can only speak from personal experience.

On dropping costs of production tools and in home recordings, indications from both producers and engineers the data tell us that this cause has impacted their job.

Role changing: The data tells us that the *tape operator* has since digital took over been replaced but the *Pro Tools operator*. Indications tell us also that the role of the second engineer has begun to disappear. A programming role seems to have been added. A participated engineer also explained that there are less musicians involved.

Indications from the data tell us that the role of the engineer in the recording production has been changing since the adoption of digital. One participant explain: “We have become ore involved in “production”. Indications also tell us that there has been a change regarding this for the producers as well. Indications from the questionnaire tell us that the role of the producers and engineers are emerging. Two participants one from the producer side and one from the engineer side agrees that this change has already happened, and is not an invention of now. It needs to be stated that two engineers answered “no” on this, they did not leave any further comments. Indications obtained from the data tell us that are more producers these days, compared to fewer recording engineers.

11. Discussion of the Literature Review and the Questionnaire Responses:

Section 11 compares the findings from the literature review to the questionnaire responses. The impact of digital storage formats, the Internet, P2P, changing communication between studios and studios and the outside world, piracy and competition from other forms of entertainment can be reconsidered against indicators that roles have changed, budgets have decreased and more time is spent on post-production.

Many changes have happened in studio production since the adoption of digital technology. New hardware and software have impacted the studio. Outside industries have impacted the studio and production practice. Indications suggest that changes have happened through the entire production process more or less, but maybe most dramatically on the post-production process. Studio roles have been replaced and changed. More editing is probably being done now compared to in the analog days because new technologies offer more functionality and more detailed operations can be performed. Some participants of the questionnaire agree that Internet technology has changed, in some ways the studio production. This might be a reality. We do see network configurations in studios, providing easier ways to communicate with others involved in the production, simplifying the transfer of material from the recordings. Because of the Internet and Internet technology, distribution has changed in both good and bad ways for consumers and music producers. The good thing is that anybody can distribute their own music through sites like “myspace.com” or Net companies providing domains for this purpose. This has led to more bands getting promoted to both labels and consumers, and establishing fan base before releasing recordings. Consumers with the help of Internet help spreading the “word” about new artists, developing markets and improving record sales.

The downside is that it is hard to copy protect digital music. It is easier to rip music from CD’s and circulates it with current Internet and encoding technologies than it is to protect it. Discussions have been going on for many years now about the Internet and P2P, and if they have impacted CD sales negatively. This is basically what the major labels are saying and there could be truth to it, but equally important is the free “advertising” that the labels, artist and bands get via P2P. This may also help CD sales. If CD sales globally have dropped, a more likely reason why is because of the professional piracy industry and not the regular home computer users. Also, the music industry has very strong competitors from the likes of the movie industry and the game industry who competing for the consumers’ entertainment money. Digital technology has also advanced in these markets as well helping them becoming more attractive to the consumers.

Regardless of new developments and good competition that digital technology brings, all digital content and the music industry are under attack from pirates who would make and sell illegal copies of recordings. However, depending on whom you ask in the entertainment

business, there are different views on who is to be responsible for stealing money from the music industry. As a result, in response to this threat the music industry is also hurting itself in three ways. First, by reducing competition. When the major labels group together and force all music to be sold for a price set they themselves set, they make it harder for small labels and distributors to compete, thereby limiting consumer choice. At the same time, the music industry is becoming more musically conservative and this also in the long run leads them to hurt themselves. Lastly, in an attempt to control music in the digital world, the major labels attack legitimate consumers who would use new, convenient digital technologies to buy and listen to music. A number of questions can be asked. What will happen to P2P? Indications suggest that the spread of music on the Internet is not going to stop anytime soon. We need to adapt more and then figure out what we can do to protect copyrighted material but still use the Internet as a major distribution channel for music. Could this mean that formats will change? That the CD will die out, and that formats like MP3 will entirely take over? What happens to the audio quality then? Blesser & Pilkington [10] have talked about the risks seen in mass market giving up quality for convenience or for cheaper products, and of course the Internet where the medium mp3 exist, also play a major part in this. If the Internet in the future will be the only way we distribute music then better audio quality formats are definitely needed, otherwise the high audio quality seen on CD's will be lost.

What happens to the independent labels? Will they survive? If not, what will that do to the types of music that get recorded? They are in danger because of the fact that the Majors are fighting a strong battle for control over the entire entertainment industry, and for the control of the mechanisms of distribution. They are also fighting for control over the internet. So do the independent labels have to "sell" themselves to the bigger labels in order to survive? What will happen to the music business will there be one in the future or just some general entertainment industry? There are different possible futures depending on future technical advances, the choices the recording industry makes, but also on how the music industry interacts with consumers in the future.

As long as there is market for Independent labels and artists, the majors will have competitors. However, some trends are obvious; budgets seem indeed to be smaller. A parallel can be drawn between the possibility of dropping incomes from CD sales and competition from other industries, giving record labels less money budgeted for recordings. Therefore, average producers and engineers are increasingly likely to get paid less. Perhaps it is so that the record companies are spending their money on supporting development of new technology protecting their records from being copied and pirated, rather than on the actual recording of the record. It sure seems as if it is becoming more and more important to protect your investments in the music industry, because the risk of theft. Regarding the role change; both answers from the questionnaire and the literature research tells us that there have indeed been changes. The "little roles" existing before has been absorbed by the engineer and name labels on roles have changed and so on.

The work is being done differently in setting up sessions, mixing, editing and ways to communicate. What happens to the role of the producer and the engineer? Will there be any jobs available in the future or will people record entire projects in their home. Is the home studio going to knock out the "real" studios entirely? Once again, what happens to the audio quality then? Will it give the same technical or aesthetic possibilities as you have in studios? We do however see that more and more professional tools find its way in to the home of the home recorder causing possibilities for the production to become more professional in technical terms, but how professional is the home recorder in terms technical control over

acoustics, audio engineering and production aesthetics? These sorts of discussions will continue to go on. The aesthetic/audio engineering approach in recordings we have to nurture, the producer participants from the questionnaire tell us that budgets for this approach is getting smaller. It is important to remind us that without seeking and supporting newer creative possibilities the industry will get even more “mainstream” than it already is. This is not an advantage for the music industry.

Discussion regarding the experiment:

This was an exploratory study used to identify areas of possible change for further investigation. Indications from the experiment only represent views of a few professionals. More subjects are needed to support these findings. Also, little information was collected about their individual experience. More details are needed to create deeper profiles of each subject. This limits the observations that can be made. Because of these reasons the findings are therefore not representative of the industry as a whole or a complete view on changes in studio production or that some changes with a certainty can be said to have happen. However, the indications that have been obtained give us some clear direction to continue to deeper research.

The changes under investigation are on-going, real-world and non-theoretical. Producers and engineers report being aware of change, but it is not yet clear how exactly to identify or categorize these changes or how to measure the rate or amount of change. The lack of clarity comes from influences coming from many directions at the same time also making it hard to know what to measure, when and how. There are also many human factors. The kinds of change and amount of change are also influenced by the personal experience of engineers and producers, their preferences, where they work (the size of the studio) and what kinds of music they record. So, this exploratory study also begins to investigate methodologies for how to incorporate these different, not easily measurable, factors into an analysis of change.

Having a new extended experiment with more participants, getting more details about personal experience and more genre specific questionnaires to get deeper into the connections between professionals’ individual experience and change in technology and production would be a good way to continue this research. Also, changes in studio production cause changes in musical aesthetics and the aesthetics of recording. Further investigations could include not only an investigation about how the digital technology changed the roles, but also how the decreasing size of budgets or the emphasis on post-production changed the music itself.

12 Conclusion:

The success of music in the digital domain depends on several things. Digital equipment is relatively cheap compared to analog equipment, and there is more ease of use and easier maintenance in digital tools making it more accessible to the mass market. The fact that several standards have been agreed upon, and funding for continued research has been available are also probably likely reasons for its growth. Regarding the role changes for producers and engineers, both answers from the questionnaire and the literature research tells us that there have indeed been changes. The “little roles” existing prior to digital have been absorbed by the engineer. The names given to these roles have also changed. The work is being done differently because technology provides new ways to work and this has been applied to the entire production chain. Home studios might eliminate commercial studios entirely. Given their expansion and the simultaneous indications on less money budgeted for the producer and engineers work, the future for the producer and the engineer is a bit unclear.

Their roles might change even more, merge even more. Technology, Society, Industry and Music Production do impact each other. But with the kind of insight we gained in this study, we may be better able to shape the future of studio production.

Personal comments from the author, a young engineer/producer: When thinking about the future for the whole music industry, adding every piece of the process from recordings to distribution I see a lot of uncertainties, but also some certainties. The uncertainties involve the future role for the recording engineer and the producer. I do believe there will be jobs for us in the future. We are important to the business because we are professionals trained in aesthetics as well as engineering, and we are motivated to keep the quality on both ends high. Fewer jobs are however likely to be available in the future given by the fact that we will continue to have tough competition from the home studio and its users. The home studio trend is likely to expand even more causing troubles for the commercial studios. The trend of fewer budgets might even continue to cause troubles. The certainties that I see is that the Internet will continue to be a great market for distributions, both for sales of physical and digital CD's but also individual song downloading. Records sales in stores are likely to continue to drop in the future. We are though in need of higher audio quality on those formats circulated on the Internet; they are not currently CD audio quality. We also need to find a better way to protect copyright material. The main thing that makes people want to record and want to buy music that has aesthetic value. We need to continue to be creative in order to keep the music industry not only alive but also flourishing.

13 References:

- [1] R. Runstein & D. M. Huber, (June 2001) Modern recording techniques, Focal Press, Oxford, England, Burlington, MA, 5th Edition
- [2] F. Rumsey & T. McCormick, (June 3002) Sound and Recording, an Introduction, Focal Press, Oxford, England, Burlington, MA, 4th Edition
- [3] S. P Lipshitz, (1998 January/February) Dawn of the Digital Age, J. Audio Eng. Soc. Vol. 46, No. 1/2
- [4] S. F Temmer, (1979 May).The Benefits and Dangers of Standardizations”, J. Audio Eng. Soc. (Letters), vol 27, p. 394
- [5] Audio in Digital Times: Proceedings of the AES 7th international conference, Toronto Canada, 1989 May 14-17 (Audio Eng. Soc. New York, NY, 1990).
- [6] T. Kikuta, (1985), The Practice of Digital Audio Recording, AES 3RD International Conference, King Record C., Ltd. Tokyo, Japan
- [7] B & J. Bartlett, (December 2001) Practical Recording Techniques, Focal Press, Oxford, England, Burlington, MA, 3rd Edition
- [8] http://www.webopedia.com/TERM/i/integrated_circuit_IC.html
- [9] K. C. Pohlman, (February 15. 2000) Principles of Digital Audio, McGraw- Hill Professional, Columbus, OH, 4th Edition
- [10] B. Blesser & D. Pilkington, (October 2000) Global Paradigm Shifts in the Audio Industry part 2, J. Audio Eng. Soc, Vol. 48, No. 10
- [11] www.kazaa.com/
- [12] <http://www.ifpi.org/index.html>
- [13] <http://umatic.palsite.com/>
- [14] P. Gronow & I. Saunio, C. Moseley (translator), (March 1999) An International history of the recording industry, Cassell, London, England, New York, NY
- [15] <http://www.riaa.com/default.asp>
- [16]<http://www.ifpi.org/site-content/library/piracy2005.pdf>
- [17] J. Morris, (October/November 1977) The Audio Engineer- Circa 1977 What does He (or She) do? J. Audio Eng Soc, Volume 25, Number 10/11,

14 Appendix Producers:

Question	Answer participant 1	Answer participant 2	Answer participant 3
1. How long have you been working?	13 years	30 years	10 years
Comments:	Comments:	Comments:	Comments:
2. Do you produce major label artists or independent artists or both?	Both	Mostly independent	Both
Comments:	Comments:	Comments:	Comments:
3. What genres or style of music do you record?	Soul/Rn'B, Rock, Country	Powerpop, singer songwriter, retro rock	All, (except white power)
Comments:	Comments:	Comments:	Comments:
4. Do you believe that the computer technology changed the way we record music today?	Yes	Yes	Yes
Comments:	Comments:	Comments:	Comments:
5.a Do you prefer analog or digital for recording instruments?	Analog	Analog	Both
Comments:	Comments: But rarely is there a budget for it.	Comments:	Comments: Analog for warmth, first in the chain. Digital for ease of use, editing collaboration, saves time.
5.b Do you prefer analog or digital for recording vocals?	Analog	Digital	Both
Comments:	Comments: But rarely is there a budget for it.	Comments:	Comments: Analog for warmth, first in the chain. Digital for ease of use, editing collaboration, saves time.
5.c Do you prefer analog or digital for mixing?	Prefers analog	Analog	Both
Comments:	Comments: But rarely is there a budget for it.	Comments:	Comments: Analog for warmth, first in the chain. Digital for ease of use, editing

			collaboration, saves time.
5.d Do you prefer analog or digital for mastering?	Almost always digital	Both	Both
Comments:	Comments:	Comments:	Comments: The files are digital but then put through analog EQ's, compressors back to digital.
6. On average, has the total length of time for recording projects (from pre-production through final product) increased or decreased since the intro of digital technology?	Increased	Increased	No real change.
Comments:	Comments:	Comments:	Comments: Less budgets from labels.
7. Same question as nr 6, but on negotiations with companies/labels?	Not Applicable	Same	More
8. Same question as nr 6 but in pre-production?	More	Same	Same
9. Same as before but on rehearsing with musicians?	Not applicable	More	Same
10. Same as before but on talking and planning with artist regarding sound, aesthetic approach, etc.	Not applicable	More	Same
11. Same as before but on talking and planning with the engineer?	More	More	Same
12. Same as before but on tracking/recording vocals and instruments?	Basic tracking: More. Overdubs: Less	More	Same
13. Same question as before	Same	Same	Same

but on communicating with performers about performance during recording sessions?			
Has what you talked about changed? If so how?	Comments: With performes, no real change. With engineers the “new” talk is usually more directed towards finding a way of making the recording sound “warm”.	Comments: Yes, in some cases. If you work with mouse clicking it can get too much focus on copy/paste. But with analog recording, withouth clicking it is just as it was before.	Comments: No. It’s the same
14. Same question as nr 6, but on editing?	More	More	Same. But different.
15. same as above, but on mixing?	Same	More	Did not answer
Comments:			
Have the people present in sessions changed since the change to digital? If yes, who was there before and after?	Comment: “Not in the way I work”	Comment: No	Comment: No
Has what you talk about with the engineer during mixing sessions changed? If so, how?	Yes, in the way of choosing plug-ins rather then using outboards.	Not applicable	Not really.
16. Same question as nr 6 but on Mastering	Same	Same	Same
Comments:			
17. Do the choices of music consumers directly affect what types of projects you work on and how you work on in the studio? If yes, how, in what way?	Not really	No	No
Comments:			

18. Are you able to work with less established artists or develop new artists more or less since the change to digital?	Absolutely more	Same	Yes
Comments:	Comments: It's cheaper; therefore there are more "small" sessions.		
19. On average are your budgets larger or smaller?	Much smaller since 2001.	Smaller	Smaller
Comments:	Comments: But not necessarily due to digital.		
20. Is more or less money budgeted for time to develop a unique sound for artists/projects?	Less money	Less	Less money
Comments:			
21. Do you spend more or less time developing a unique sound for artists/projects?	About the same	More	The same amount
Comments:	Comments: I feel you have to give each artist a unique sound.		
22. Has Internet technology (other than P2P file sharing) affected music production?	No	Yes	No
Comments:	Comments: Not in the way I see it. "I think that the overall climate regarding the entertainment industries has changed. Music has a lot more competition from games, film, sports."	"I usually mix on distance and send mp3 versions of the mix, and I can get quick replies on possible comments, so that everything is of satisfaction."	"A little, I can send pre-mixes over the Net instead of mailing a CD, and the ability to chat with video has changed sessions were I collaborate globally".
23. Has P2P file sharing impacted budgets?	Yes	Did not answer	No
Comments:	Comments: Absolutely		"That's just propaganda from the Major labels!

24. Has the dropping costs of production tools and increased in home recordings impacted your job? Yes or No	Yes	Yes	Yes
Comments:		“A lot of mixing is to be done when bands records in home or in a small pc based studio. Everything to keep the costs done. Six years ago you could take 5.000 SEK each day on mixing. These days half of that“.	
25. Are there more or fewer music producers today?	A lot more	Probably more	Far too many!
Comments:		“If you have a PC and the interest you can work with fewer things, which makes it possible to get working with music out to a wider scale of people. It’s cheap and you don’t need a studio on 200 m2 that costs a lot of money”.	
26. Has the number of personnel in the average recording session increased or decreased in studios over the years?	Decreased	In my case , no difference	It depends
Comments:			
27. What roles have been added or removed?	Tape operator, second engineer	No difference	Added: Programming, ProTools editing, and system operator.
Comments:		“I’ve always taken in the role that each project demands of me. Sometimes only as an engineers, mostly both as an engineer and producer, and	

		make sure that the people involved really get what they want”.	
28. Do you see the role of the producer changing since the adoption of digital?	Yes	Did not answer	Yes
Comments:	A lot more song writers also become producers	“I can only see it from my point of View and digital technology had nothing to do with it”.	
29. Do you see the role of the producer and engineer emerging?	yes	Did not answer	It’s already happen
Comments:		“For me it’s always been a shared interest for the technical and the musical, and through the years I’ve realized that it is the musical side that always is the most important one”. ...”Digital curiosity mostly just ruined the music. Good thing one finally woken up”.	

Appendix Engineers:

Question:	Participant 1	Participant 2	Participant 3	Participant 4
1. How long have you been working?	18 years	30 years	25 years	22 years
2. Do you produce major label artists or independent artists or both?	Both. About 40% major and 60% independent.	Both	Mostly independent	Both
3. What genres or style of music do you record?	On recording; classical and Jazz.	“Acoustic music, with a concentration in Jazz”	Rock, pop, jazz and folk	Rock, pop, jazz, classical
Comments:	“85% of my time is spent in the mastering studio. In that environment I work on every possible type of music imaginable”. 10% classic, the rest, popular genres.			
4. Do you believe that the computer technology changed the way we record music today?	Yes	Yes	Yes	Yes
Comments:	“The largest effect of computers on music falls into 2 areas. The first is the obvious; we have much more powerful tools to create music. The ability to edit seamlessly, auto-tune vocals and recall mixes and update changes with 100% reliability are huge advances. The secondary effect of computers and technology in general is a radical shift in the decision making process”...”Nowadays , decisions are made much later in the production process.	“Computer has made repeatability, in regard to both audio quality and DSP, second nature”.	“You have more choices and more decisions to take later in the production, because you often save all to be decided later on , on what’s going to be in or not. In the old analog technique you looked at it differently on the production and on decisions making”.	
5.a Do you prefer analog or digital for recording instruments?	It depends on the type of music.	“Sometimes analog, sometimes digital. Analog sound better but is too expensive for most clients”.	Analog	Both

Comments:	“For classical we use the highest resolution digital available due the need to edit the material later.” “However for jazz, most times my first choice for multi-track will be 15ips CCIR or 15ips NAB with Dolby SR”.			“Different sounds depending on the recording media”
5.b Do you prefer analog or digital for recording vocals?	Same as 5a.	“Sometimes analog, sometimes digital. Expense is the difference”.	Analog	Digital
Comments				
5.c Do you prefer analog or digital for mixing?	Again it depends on the situation.	Always analog	Analog	Both
Comments	“If the mix needs to be recalled and revised, the obvious choice is digital, however I feel that there is a sound to an analog summing bus that has not been duplicated in digital. So for pure aesthetics, analog is more desirable, but often the more important factor is facility to do revisions”.			“Different sounds depending on the recording media”
5.d Do you prefer analog or digital for mastering?	“I use a hybrid approach. Analog and digital tools have their strengths. I use the appropriate tool for the job”.	“I always mix to analog tape but it needs to be digitized for Compact Disc”.	Both	Both
Comments				“Different sounds depending on the recording media”
6. On average, has the total length of time for recording projects (from pre-production through final product) increased or decreased since the intro of digital technology?	“The ability of the artist to do more of the production work at home has generally caused the time for the completion of a project to increase. Also the ability to do very fine detailed work in the digital domain takes much more time”.	“It hasn’t changed the time frame at all”.	About the same as before	Increased
Comments				“The possibilities often make artists and musicians lazy.”

				More takes of each song, more editing, more fixing bad singing and playing”.
7. Same question as nr 6, but on pre- production?	Not applicable	Same	More	More
Comments				
8. Same question as nr 6 but on talking and planning with the producer regarding technical issues such as equipment, monitoring etc	Not applicable	Same	Less	Same
Comments				
9. Same as before but on talking and planning with the producer regarding aesthetic approach?	Not applicable	Same	Less	Same
Comments				
10. Same as before but on how much in studio time do you spend setting up a session?	Less	Same	Did not answer	Depends on session
Comments			“2-5 hours”	“30 minutes to 3 hrs
11. Same as before but on tracking/recording vocals and instrument?	Not applicable	Same	It depends	Depends on session
Comments				“First takes - several days”
12. Same as before but on communicating with musicians during sessions?	Same	Same	Less	Same
Has what you talked about changed? If so how?	“Yes, musicians are much more involved in the production process than in the past. Many have a good knowledge of the recording process	“Yes, DSD or PCM in regard to PCM bit depth & sample rate”.	Yes	

	and what can and cannot be done”.			
Comments			“we talk more about details today”.	
13. Same type of question as nr6 but on communicating with producer during recording sessions?	Same	Same	Same	Same
Has what you talked about changed? If so, how?		No		
14. Same question as nr 6, but on editing?	More	Less	Did not answer	More
Comments	“Editing has increased exponentially. In the past, a classical record with 50 minutes of music would have 100-150 edits. Now the norm is for 300+”.			
15. Same as above, but on mixing?	More	More	More	More
Comments:	“The available technology has opened many options to make changes, and these changes slow down the process greatly”.			
Have the people present in sessions changed since the change to digital? If yes, who was there before and after?	Yes and no.	Yes	No	No
Comments:	“In the past there was the tape operator. The have been replaced by the ProTools operator”.	“Always a (box operator) ProTools, DP etc		
Has what you talk about with the producer during mixing sessions changed? If so, how?	Not really	No	No	No
16. Same type of question as nr 6 but on Mastering		Answered “yes” unclear on what.	Answered “no” unclear on what.	Answered “no” unclear on what.
Comments:	“The mastering			

	session has gone from 10-12 hours as the norm to 6- 8”			
17. Do the choices of music consumers directly affect what types of projects you work on and how you work on in the studio? If yes, how, in what way?	“No, we are trying to make the best possible product, regardless of the delivery medium”.	Yes	No	No
Comments		“Now you may think about a quick track to downloaded”.		
18. Are you able to work with less established artists or develop new artists more or less since the change to digital?	Less	More	Yes	Did not answer
Comments	“The large companies no longer develop new artists’ careers, they release records. The norm is for unsigned artists to do a complete record and then shop for a label, rather than the other way around”.			
19. Do you spend more or less time developing a unique sound for artists/projects?	Not applicable	Same	Less	Did not answer
20. Has Internet technology (other than P2P file sharing) affected music production?	Yes	Yes	No	Yes
Comments	“It is very common for the delivery of materials for mastering to come over the FTP server”.			
21. Has P2P file sharing impacted engineers’ salaries or the number of	Yes	Yes	No	No opinion

available jobs?				
Comments:	“The money to pay for records has to come from somewhere. If you cannot sell you product because of theft, it is difficult to stay in business. Unfortunately the technology is ahead of morality. People will not pay for what they can get for free. Unless there is some vehicle to assign value to IP over the Internet, this business is going to fail”.	“In general the whole paradigm of the assistant engineer has shifted, there are not many large studio jobs available”.		
22. Has the dropping costs of production tools and increased in home recordings impacted your job? Yes or No	Yes	Yes	No	Yes
Comments:	“We charged more for our services in 1988 than we do today. The access to technology is the direct cause”.			“ Bad engineered home recordings needs to be imported to the real session”.
23. Are there more or fewer recording engineers today?	“There are more people recording, but far fewer engineers”.	“Less engineers, more (Box operators), people that just edit or rum the (Box) during tracking”.	Less	Less
Comments:	“The training of engineers and the need for technical skills has dropped significantly in the computer age”.			“Less craftsmen - more self taught”
24. Has the number of personnel in the average recording session increased or decreased in studios over the years?	Basically the same	Decreased	Decreased	No change
Comments:				
25. What roles have been added pr removed?	“The tape operator has been replaced by the ProTools operator”.	“Less second engineers”.	“Less musicians”	“Sometimes on person alone only runs the DAWs”.
Comments:				
26. Do you see the role of the	Not really	Yes	Yes	Yes

engineer in the recording production changing since the adoption of digital?				
Comments:		“We have become more involved in “production”.		“The artists need the engineer to create their performance on a record”.
27. Do you see the role of the engineer and the producer merging? If yes how?	“This happened about 30 years ago with the move from the record company studio to the private studio”.	Yes	No	No
Comments:		“Less producer only people, most often now the artist is the producer so he’s in the studio playing”.		