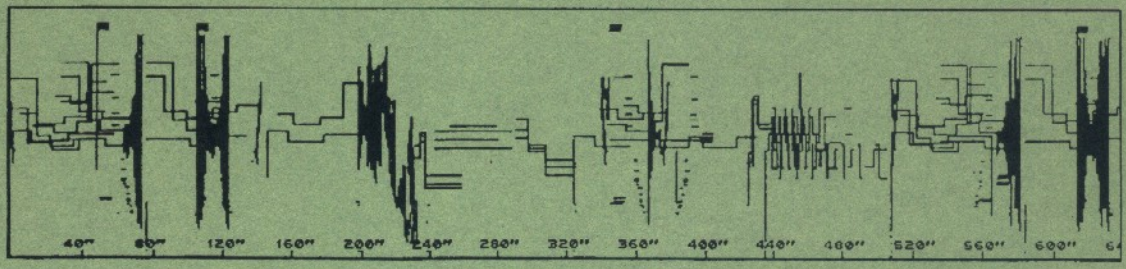
INSTITUT FÜR ELEKTRONISCHE MUSIK UND AKUSTIK
AN DER UNIVERSITÄT FÜR MUSIK UND DARSTELLENDE KUNST GRAZ

BEN BENGLER

THE AUDIO MIXER AS CREATIVE TOOL IN MUSICAL COMPOSITION AND PERFORMANCE



BEITRÄGE ZUR ELEKTRONISCHEN MUSIK 13

Die Reihe “Beiträge zur Elektronischen Musik” stellt Arbeiten des Instituts für Elektronische Musik und Akustik Graz zu den Themenbereichen Akustik, Computermusik, Musikelektronik und Medienphilosophie vor. Dabei handelt es sich meist um Ergebnisse von Forschungsarbeiten am Institut oder um überarbeitete Vorträge von InstitutsmitarbeiterInnen.
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Wir hoffen, dass die Schriftreihe “Beiträge zur Elektronischen Musik” eine Anregung für Ihre wissenschaftliche und künstlerische Arbeit bietet.

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The series “Beiträge zur Elektronischen Musik” (contributions to electronic music) presents papers by the Institute of Electronic Music Graz on various topics including acoustics, computer music, music electronics and media philosophy. The contributions present results of research performed at the institute or edited lectures held by members of the institute.
The series shall establish a discussion forum for the above mentioned fields. Articles should be written in English or German. The contributions can also deal with the description of projects and ideas that are still in preparation and not yet completed.

We hope that the series “Beiträge zur Elektronischen Musik” will provide thought-provoking ideas for your scientific and artistic work.

Alois Sontacchi (editor)

The audio mixer as creative tool in musical composition and performance

Ben Bengler

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Preface

It is a great pleasure to announce the contribution of Benedikt Bengler in the present volume of Beiträge zur Elektronischen Musik. He prepared the main parts of this contribution during a scientific project at the IEM. According to the goals of this curriculum, his work brings together technical and artistic expertise and is highly interdisciplinary. I gratefully thank the author Mr. Bengler for carrying out this work at our lab. I owe special thanks to my colleague Gerhard Eckel (IEM, KUG) who assisted Mr. Bengler's project as a mentor and supervisor.

I wish you an enjoyable reading experience with this issue of BEM.

Alois Sontacchi

Introduction

Since the beginnings of technology-based music production, the audio mixer has occupied a central role. Due to its basic functionality to mix and balance different sound sources while controlling their spatial and spectral properties, the process of mixing becomes a pivotal layer fusing together all kinds of recorded or electronically generated sounds into a new musical composition.

This article investigates how composers and musicians have utilized these elementary characteristics for artistic reasons and in what kind of creative ways they exploited the potentials of mixing technology.

The observations follow the creative use of mixing equipment from the first electronic studios in the late 1940s up to the present day, where audio mixers are often realized completely in software. Beside the audio mixer's significance for the composition and performance of electroacoustic music, the article also considers its creative usage in popular music: The observations range from the extensive use of mixing technology in pop music starting with the advent of multi-track recording in the early 1960s to the virtuosic mixing techniques that evolved in popular sub genres like Dub music or Hip Hop.

By taking a look at the last 70 years of music from a perspective behind the mixing desk, this article aims at illustrating the wide diversity of approaches utilizing the audio mixer as a creative tool in musical composition and performance.

Chapter 1

The origins of mixing technology

The origins of audio mixing date back to the 1920's. Before 1925, the recording process was entirely mechanical. The foundations for electrical recording were laid by the development of the condenser microphone and improvements in the electronic tube amplification. In the mid-1920's the first electrically recorded 78 rpm discs has been produced. The first electronic mixing equipment appeared in the film industry when the optical motion picture soundtrack was introduced in the late 1920's. Companies like RCA and Western Electric developed re-recording mixers for the production of motion picture soundtracks. Until the advent of long-playing records in 1948, the optical film soundtrack should stay the only recording medium with a longer recording time than the common 78 rpm discs that were restricted to a few minutes. The techniques of re-recording also raised the interest of composers: In 1937 the Mexican composer Carlos Chavez examined in his influential book "Towards a New Music: Music and Electricity" the possibilities of re-recording having a presentiment that this kind of methodology will influence the future of working with sound:

> *"In the course of re-recording, we can use all the resources of electrical transmission. We can amplify all or parts of the sound, correct the tempo, give accents or weaken certain passages.""*
>
> [Chavez, 1937, pp. 71-72]

In the early 1930's the first radio broadcast consoles appeared implemented as passive control surfaces aligned with a rack of amplifiers. In 1931 the first comprehensive, theoretical description of stereo sound was given in the seminal patent 6 specification of the English engineer Alan Blumlein. Two years later

Harvey Fletcher and his team of the Bell Laboratories accomplished the first multichannel live transmission in collaboration with the conductor Leopold Stokowski: The sound of the Philadelphia Orchestra, conducted by Stokowski's assistant Alexander Smallens, was recorded with three microphones at the Academy of Music in Philadelphia and played back at the Constitution Hall in Washington using three loudspeakers. Stokowski himself operated a threechannel mixing panel located at the rear of the concert hall. Therefore Stokowski can be considered as the first one operating a stereo mixing device [Torick, 1998].
Harvey Fletcher, elaborating on stereo mixing and re-recording techniques like modifying volume ratio or tonal colour, concludes that the re-recorded material is enhanced "with the result that upon reproduction, a musical interpretation is possible that would be beyond the power of all original orchestra, speaker, or singer to produce" [Fletcher, 1940].
In 1936 the Collins 12H has been released being the first manufactured broadcast mixer that combined control surface and amplifiers in a tabletop enclosure. It provided four microphone channels and an elementary monitor section. Another important development in early mixing technology was also introduced by the film industry: For Disney's animation movie Fantasia a multichannel format called Fantasound has been developed. Thereby the first constant-power pan pot has been designed to smoothly move sound sources around within a multiple speaker setup [Garity, 1941].
At Fantasia's debut in New York's Broadway Theater in October 1941, surround channels were utilized for the very first time in the last piece of the movie's soundtrack – Schubert's Ave Maria: The sound engineer performed all fades and pannings in real-time under the supervision of the conductor Leopold Stokowski realizing the first surround mix ever - a milestone in sound technology that foreshadows what is to come in the following seventy years.

Chapter 2

Mixing techniques in early electronic music

In 1948 Pierre Schaeffer started to experiment with the equipment of the Studio d'Essai at RTF (Radio Télévision Française) in Paris. This led him to an entirely new methodology of composing music. The fundamental technique for these very first electro-acoustic compositions was to use pre-recorded, 'concrète' sounds as source material. By modifying and combining these sounds he created both the tonal content as well as the musical structure. Schaeffer called his approach of composing 'musique concrète'.

From a technological point of view the Studio d'Essai was a typical studio used for radio drama at that time: For his early compositions Schaeffer could utilize four turntables, a four-channel-mixer, electric filters, an echo chamber and a recording unit. The compositional process had to be performed in 'real-time': Schaeffer controlled, manipulated and mixed several records containing the source material while the compositional result – the output of the mixing desk – was directly recorded to shellac disc with a disc-cutting lathe.

The level controls of the mixing desk – still implemented as large rotary potentiometers at that time – became a crucial tool in the procedure of composing musique concrète. Schaeffer described the compositional process of the *Étude Pathétique [Étude aux Casseroles]*, which just took a few minutes, as an "exercise in virtuosity using four potentiometers and eight ignition keys[1]" [Schaeffer, 1950,

[1] The original quote (French) has been translated by the author. The term 'ignition key' probably describes some kind of turn-switch.

p.43]. In his article about the development of the Groupe de Recherches Musicales (GRM), Marc Battier tellingly describes the significance of manipulating the sound level in order to turn the source material into something new:

> *"Throughout the twentieth century the artist has shown how he can transform the machine into a basis for creation. [...] This machine, in the Club d'Essai's studio, was [...] represented by the turntable, but it was also the potentiometer of the mixing desk. [...] Using the mixing desk's potentiometers, one's action leads to a new dynamic outline, which, in some cases were able to mask the identification of the source: the sound sheds its envelope and becomes disembodied."* [Battier, 2007]

In 1952 the young German composer Karlheinz Stockhausen, who studied with Oliver Messiaen in Paris at that time, had the opportunity to experiment in the Studio d'Essai. There he composed *Étude* – his only work that is exclusively related to musique concrète. When Stockhausen returned from Paris in 1953, he started to work with purely electronic sounds in the electronic studio of the WDR in Cologne, which has been founded by Werner Meyer-Eppler and Herbert Eimert two years earlier.

He composed *Studie I* and *Studie II* using pure electronic sounds realized by additive synthesis: Stockhausen took pure sine tones as source material and combined them into a complex sound (Tongemisch). Via further layering of several complex sounds Stockhausen synthesized complex sound textures. This approach can be seen as a first manual, step-by-step realization of electronic sound synthesis: The mixing process of source waves with different frequencies and specific sound level ratios provides the methodical basis for the following electronic synthesizer technology.

In 1955-56 Stockhausen realized his first major electro-acoustic work: *Gesang der Jünglinge*. The piece is composed of several pre-mixed sections. Every section consists of multiple textures, which were produced in a kind of real-time, in-studio performance with three musicians handling the studio equipment to realize complex timbre changes.

> *"Let me describe how we've gone about making a sound texture of twenty seconds' duration. I sat in the studio with two collaborators.*

> *Two of us were handling knobs: with one hand, one of us controlled the levels and, with the other hand, the speed of pulses from a pulse generator which were fed into an electric filter; a second musician had a knob for the levels and another for the frequency of the filter; and the third one would manipulate a potentiometer to draw the envelope - the shape of the whole event - and also record it. I drew curves - for example: up-down, up-down, up-down up-down, up, which had to be followed with the movement of a knob (let's say for loudness) for the twenty-second duration. And during these twenty seconds, another musician had to move the knob for the frequency of the pulses from four to sixteen pulses per second in an irregular curve that I'd drawn of the paper. And the third musician had to move the knob for the frequency of the filter following a third curve.[...] this resulted in an aleatoric layer [...] Then we'd make a second, third, fourth, fifth layer [...] and I'd syncronized them all together and obtain a new sound "*
> Stockhausen in [Cott, 1973, pp. 71-72]

Similar to Schäffer, Stockhausen utilized the level potentiometers to shape the dynamic outline of the sounds. But due to his gradual, additive approach, enabled by the new available tape technology, he could obtain a much higher dynamic complexity: Manipulating the levels of the impuls generator and the filter (probably directly at the device) let him shape the inner dynamic structure. With the level potentiometers of the mixing desk he created an overall envelope for every layer. By mixing these 'pre-formed' layers he created the final texture. During this mixing process the timbre of the texture could be influenced by adjusting the level ratios between the seperate layers. In addition, spatial movements of sound could be realized as *Gesang der Jünglinge* was the first multichannel tape composition. Also other electronic studios used mixers and signal generators to implement electronic sound synthesis: In 1955 the Studio di Fonologia Musicale was founded of RAI (Radiotelevisione Italiana) in Milan, Italy. It was one of the best equipped electronic studios with mostly custom-made devices built by its technical director Alfredo Lietti. The studio had nine parallel sine-oscillators which could be mixed and pre-listened before recording. Having in mind that Stockhausen had to record and mix the corresponding sine tones layer by layer, it becomes obvious how the synthesis process had been simplified by mixing nine discrete sources at

once, especially in terms of realization time. The studio had a 16 channel console with remote-controls for the equipment. Major works of Luciano Berio and Bruno Maderna, the founders of the studio, were realized in the Milan studio as well as other important works by Pousseur, Nono or Cage. Refering to Berio's work with the singer Cathy Berberian Marino Zuccheri, the chief technician and mastermind of the studio, once stated that Berberian's voice *"had become the 'tenth oscillator' of the studio"* [Halfyard, 2004].
A few years later the first American electronic studio was founded: In 1959 the Columbia Princeton Electronic Music Studio was opened built by the engineer Peter Mauzey after consultation with Vladimir Ussachevsky. The studio setup was designed for tape music as well as for pure electronic sound generation. Four of the eight sine-generators were patched to the eight-channel mixer per default. In 1958 Mauzey presented a very detailed, technical description of the studio at the 10th annual meeting of the AES containing a circuit diagram of his mixer design. He gives also a suggestion for a creative use of the mixer's output selectors:

> *"The DPST switch is unexpectedly useful. It makes possible the quick and simultaneous removal of two channels from the main output and switches them to the 4AB output. This might be used, for example, when mixing 6 sinusoidal oscillators with two square-wave generators. The 'accent' added by the square wave generators can be removed rhythmically by operating the switch."* [Mauzey, 1958]

An example for a composition that was realized at Princeton by mixing sine waves is Bülent Arel's *Postlude* from *Music for a sacred service* composed in 1961.
During the 1950's studios were also founded in Tokyo, Eindhoven, Santiago de Chile or Munich: Electronic music had gained ground all around the world – and should develop as fast as its underlying technology.

Chapter 3

The 60's and 70's - Technical innovations and their impact on audio mixing

During the 1960's important developments in music technology occurred: Due to advancements of the transistor, the vacuum tube technology was replaced by solid-state electronics. The introduction of voltage control enabled modular synthesizer design and the first op-amps were used as summing devices enabling the design of flexible multi-channel consoles at the end of the 60's.

3.1 Mixing pure waves: The modular synthesizer

The mixing of the source waves, which was done before by a stand-alone mixer, now became directly integrated into the modular synthesizer architecture.
In 1964 Robert A. Moog presented his seminal paper *'Voltage-Controlled Electronic Music Modules'* at the AES Convention in New York. One year later the first Moog modular systems became available. In the same year Don Buchla developed the Buchla 100 series commissioned by Ramon Sender and Morton Subotnick, who founded the San Fransisco Tape Music Center in 1962. Using the Buchla 100 Morton Subotnick realized *'The Silver Apples of the Moon'* in 1967, the first large-scale electronic work commissioned by a record company.
Buchla and Moog offered a variety of different mixing modules for their modular systems:

Moog:

- 984: 4x4 Matrix mixer
- 984: CP3: 4x1 Mixer: 'standard' mixing module of the later modular systems (e.g.: 4xCP3 in the Moog 55 system)
- CP11: 4x2 Mixer

Buchla (100 series):

- 106 Mixer: Two 3-channel mixers with both separate and common outputs and level controls for each input.
- 107 VC Mixer: Two 5-channel mixers with both separate and common outputs. Input levels are controlled by externally applied control voltages.

The Buchla 200 series, released in 1970, offered new modules suited for quadraphonic sound production:

- 205 Matrix mixer: Can be used as two 5x4 mixers or one 10x4 mixer
- 226 Module: 16 inputs, organized in four groups, level control of every group via voltage control or manually, level meters and headset drivers for monitoring
- 204 Quad spatial director: Voltage controlled, quadraphonic distributor with pan pots and four joysticks

The modules 205, 226 and 204 could be combined to a powerful, flexible quadraphonic mixing environment. A composition using the quadraphonic possibilities of the Buchla 200 system is Morton Subotnick's *'Sidewinder'* from 1970.

3.2 The advent of solid-state technology

The improved transistor technology paved the way for solid-state audio equipment in the early 1960's. The advantages were a smaller size, a lighter weight as well as a more economical production.
In 1964 Rupert Neve built the probably first commercial transistor-based mixing

console for Philips Recording London. In the following years the first solid-state, modular mixing systems appeared.[1] From the late 1960ies the use of op-amps as summing devices enabled the development of mixing consoles with complex bus and routing structures.[2] Soon op-amps were also used to realize active filters, pre-amplifiers, compressors and limiters that were integrated in the mixing desk.[3] Furthermore the use of op-amp based circuitry resulted in a significant advancement of the audio quality.

The integration of previous outboard equipment and the comprehensive routing facilities directly at the desk have further manifested the mixing console as the central element of the studio. Also remote controls for the tape recorders were built into the mixing desk to enable one-man handling of the studio environment: In the course of modernisation of the electronic studio in Cologne in 1967 for example, transistor generators for remote tape speed control were integrated into the mixing desks [Morawska-Buengeler, 1988, p.46].

The new technical features of the mixer have also changed the workflow of composing. A representative example for this development is the 'Studio54' – the new electronic studio of the GRM in Paris: At the end of the 60's the new 24 channel console and the 'Coupigny' synthesizer arrived in the studio. The mixing desk provided comprehensive facilities to patch and integrate external studio equipment as well as built-in remote controls for the tape recorders. The synthesizer, developed by François Coupigny, was designed according to the attitude of musique concrète: The synthesizer acted to a greater extent as a sound event generator, offering global parameters instead of precise, parametrical control, which was rejected by Schaeffer. Daniel Teruggi, who currently is the Head of Research and the Director of GRM, emphasizes the importance of this development:

> *"These two tools would have a major influence on the evolution of GRM. They are presented together since they were coupled in the same desk [...] and organized in such a way that they could easily be used by a composer."* [Teruggi, 2007]

[1] Description of an early modular mixing console: John P. Jarvis Langevin, A modular audio facilities mixing system , presented at 33rd AES Convention, 1967 [Jarvis, 1969]

[2] A comprehensive description of an early op-amp mixing console: Lyle Fain, An unusually flexible op amp mixing console, presented at the 36th AES Convention, 1969 [Fain, 1969]

[3] A very first tutorial on using op-amps for studio technology: Ralph Gittleman, Applications of the Audio Operational Amplifier to Studio Use, presented at the 34th AES Convention, 1968 [Gittleman, 1969]

The fact that the new studio was designed in such a way that the composer is able to operate the equipment from his position at the mixing desk was contradictory to the to the previous role allocation within a radio station:

> *"It should be remembered that musique concrète developed within the French National Radio into a highly structured enterprise, with trade unions controlling each category of technicians and production staff defining precise activities for each task. The isolated work of the musique concrète composer went against the existing organisation, since it fused together in the same person technical and creative actions, when these two activities were completely dissociated within the institution's structure!"* [Teruggi, 2007]

Remaining active until 1992, more than 600 works had been realized with the mixing desk and the 'Coupigny' synthesizer. Famous examples are François Bayle's *L'expèrience acoustique* composed in 1972 or Bernard Parmegiani's *De natura sonorum* composed in 1975.

3.3 The rise of the producer – Constructing music at the mixing desk

> *"I want to sound different today, nothing I sounded yesterday"*
> John Lennon, cited by Engineer Richard Lush [Zolten, 2009, p.51]

In the mid 1960's a new approach of producing pop music started to appear: Instead of being a true-to-original rendering of a real musical performance, a track was constructed in the studio in such a way that couldn't be performed live. The sound engineer gains an essential influence on the artistic process and becomes a co-creator with the musicians – the creator of their distinctive sound. In the course of this, studio technology became a part of the artistic process. With producers like Phil Spector and his voluminous 'Wall of Sound' productions the phenomenon of the 'star producer' arose.
In 1966-67 the Beatles recorded their famous album *Sgt. Pepper's Lonely Hearts Club Band* with producer George Martin. During the production several pictures were made showing the Beatles together with Martin grouped around the massive tube mixing console at the Abbey Road Studios – the mixing desk became

a status symbol for the creative producer as well as for the creative, technical skilled musician – a phenomenon that still persists.
The REDD 37 mixing desk that was used for the Sgt. pepper recordings was built by EMI and provided eight mic inputs, 4 subgroups and a 2-band Equalizer (highs, bass). As there were just two four-track recorders available it was necessary to make several mixdowns during the production. As soon as the four tracks where used on one machine the engineer made a mixdown that was recorded on a single track of the master recorder. This process was repeated until all four master tracks where used. Therefore the engineer had to perform the submixes with foresight – he had no possibilities to alter the level balance or the equalizer at a later time: The submixing process required intuitive decision making while being aware how the song will evolve.
Beside tape manipulation, new instruments and miking techniques (multi-miking for drums), several innovations in sound were achieved with the mixing console: The first fade-in of a track (*Eight days a week* (1964)), changeable EQ-units allowing different sound characteristics or the direct insert of the bass into the console resulting in a thinner but clearer sound. In particular the stereo separation of the instruments – often utilized quite drastically at the *Sgt. Pepper* production – led to a much clearer and defined sound.
The REDD 37 console, built at the peak-time of high quality tube equipment was replaced in the late 60's by a new and bigger transistor-based desk: The new EMI TG12345 had 24 inputs and 8 outputs (both transformer-balanced) and offered a compressor/limiter in every channel. But despite the novel possibilities the musicians moaned about the loss of the " tube-warmth"- a subject of a still ongoing discussion.

> *"There was less body in the guitar sound"*
> *"[I] was playing as hard as ever, but I didn't hear the same impact "*
> George Harrison and Ringo Starr cited by engineer Geoff Emerick
> [Geoff Emerick, 2006, p.277]

From the 50's to the 70's the sound of pop music changed drastically: The new studio technology enabled a change in the balance of the instruments: In the 50's the melody took the main part in the song while the rhythm section was mixed in the background. It sounded quite diffuse and was barely important for the musical context. At the end of the 60's more rhythmical accented styles like Funk empha-

sized the relevance of the rhythm section and it became an equal part of the mix. At the begin of the 70's bass and bass drum evolve into the most important instruments in a pop record's mix. In his essay *'The Studio as Compositional Tool'* from 1979 Brian Eno uses the album *Fresh* of Sly and the Family Stone as an example for this turning point: In contrast to the former records bass and bass drum take over the dominant role in the mix. Beside that, also the timbre changes: The use of dynamics led to pronounced attacks of the bass and the bass drum was explicitly equalized to realize a clear and defined sound with more 'kick'.
This shift in sound lay the basis for beat and bass dominated disco music of the mid 70's and has influenced the development of pop music down to the present day.
At the begin of the 70's a new generation of pop/rock musicians used the technology to dissociate themselves from the established 'sweetish' pop sound: Bands like King Crimson, The Jimi Hendrix Experience or Emerson Lake and Palmer tapped the full potential of studio technology to create their unique sound.
One example for a musician taking over the role of the producer by himself is Frank Zappa: Producing non-conformist, musically complex rock music, Zappa is an example for the highly technically skilled musician, who doesn't rely on a producer to create his unique sound. In the credits of his records he appears as producer, sound engineer, main performer, keyboarder, vocalist, percussionist or even as mastering engineer. Like the Beatles, who paid tribute to Stockhausen by including his picture on the cover of the *Sgt. Pepper* album, also Zappa was inspired by avant-garde music – especially by Edgar Varèse. But in contrast to Beatles producer Martin, who integrated the new sonic possibilities carefully in the song structure, Zappa arranged his music on the desk with sudden, raw cuts and drastic musical transformations, never hiding its origin in the studio. Ben Watson, referring to the album *Burnt Weeny Sandwich* from 1970, stated that Zappa is *"using the mixing desk as a form of musique concrète* and that he is when *"mixing with attention to Varèses 'blocks of sound', [...] less concerned to keep metrical order than to contrast the objective musical 'weight' of the playing on the separate bands of the multitrack"* [Watson, 1996]. Zappa described his workflow once as building a *"junk sculpture"* [Steel, 1991] – a describtion that matches with Varèse's idea of 'blocks of sound'.
In pop music the discrepancy between a piece that was entirely constructed in the studio and its live performance is a general issue: Zappa intentionally plays

with this contrast. Watson illustrates the well arranged tension between highly complex, constructed material and live-played rock music:

> *"The presence of music concrète amongst 'regular' rock music points to how artificial is music realized on a mixing desk: [...] The psychedelic rock-out of "The Orange Country Lumber Track" is suddenly cut-off – we're laughed at – and the record ends with the title track, two minutes of excruciating feedback, recorded live in Birmingham, England [...] Zappa's music concrète foregrounds the technology of mixing, but not in order to diminish recording's documentary power.*" [Watson, 1996]

Being a multi-instrumentalist on the one hand and a studio wizard on the other – Zappa had everything under control when realizing his extravagant rock compositions. A vivid illustration is the cover of the 1972 produced album Waka/Jawaka, which was inspired by the work of Miles Davis with Teo Macero. Both did endless recording jams and constructed the tracks afterwards at the mixing desk. A picture in the gatefold shows Zappa sitting on the studio console handling the faders – a musical master being in total control.

Besides pop and rock music the development of studio technology found also its way into classical music. The probably most outstanding example for the use of technology is the Pianist Glenn Gould: From the very first he was interested in utilizing studio technology to realize his vision how the music should sound. He didn't use tape splicing techniques for correction issues but to gain total control of the sonic outcome: He aimed to create a performance that is *"far superior"* to a normal recording. With the use of technology he wanted to *"transcend the limitations that performance imposes upon the imagination"* [Gould, 1966]. Karen Kieser, the General Manager of Glenn Gould Studio at CBC Radio between 1992 and 1994, describes Gould's fondness for working at the radio and in the studio:

> *"For Gould, the attraction of the radio documentary and the recording studio was the opportunity for complete control. Whether scripting both sides of an interview, painstakingly editing between multiple musical takes or rebalancing dynamics at the mixing console, he revelled in his precise personal determination of the finished product.*" [Kieser, 1997]

An comprehensive insight how Gould used mixing technology to control the sonic result is given in the documentary *"Glenn Gould – The Alchemist"* from Bruno

Monseingeon[4]: For the recording of Scriabin's *Désir* Gould uses several pairs of microphones with different displacements from the piano: One is placed inside the piano, another at a conventional distance (Gould calls it the "Deutsche Grammophon position") and another one considerably distant from the piano. Gould compares his approach with different perspectives in the cinema: Long shot, tight shot, wide angle shot that one is able to intercut. In the mixing process – instead of choosing one main-microphony – the engineer mixes the playback of all microphones at different distances dynamically according to Gould's very accurate specifications: In the beginning Gould is adjusting the starting levels of the several playbacks. Then, face-to-face with the mixing engineer, Gould is reading the score while directing the engineer like a conductor: *"Bring up two!"* (the volume fader of playback two) *"Don't take out one, bring out three!"* In this way Gould 'synthesizes' his intended piano sound for every musical situation in the piece. This quite unusual way of mixing represents his belief that *"certain kinds of music cry out for technology"*. The mixing desk helps him to approximate his very particular musical ideal. As this ideal is not attainable in a live situation he gives his last public concert in 1964. The following twenty years Gould dedicated himself to work in the studio exclusively.

> *'Recording is the only way I can play music for the public.*"
> Glenn Gould in *The Alchemist*

[4] *"Glenn Gould – The Alchemist"* was produced in 1974 as TV documentary and re-released by EMI Classics as DVD 2002, Catalogue Number 0724349012899

Chapter 4

The mixing desk in concert

4.1 The composer takes control

> *"The composer becomes his own interpreter."*
> [Stuckenschmidt, 1927]

In this way H.H. Stuckenschmidt described the influence of technology on musical performance in his visionary article *Machines: A Vision of the future* – written more than 20 years before the first public concert of electro-acoustic music by Pierre Schaeffer in 1950.
From the very first, electro-acoustic music has been composed in the studio. Therefore the question arose how to present such a work, stored on a recording medium (shellac, tape), to an audience in a concert situation.
A common approach is to control the levels and the spatial distribution of the pre-composed material during the performance. This 'real-time sound diffusion' emerged already at the beginning of electro-acoustic music: For the piece *Symponie pour un homme seul* (1951) Schaeffer and his collaborator Pierre Henry developed a spatial control system for live performances – the *potentiomètre d'espace*. This system was used to control the dynamics as well as the panning of monophonic sounds: Holding a small transmitting coil in the hand, the performer was able to distribute a monophonic sound between four loudspeakers by moving the hand in or out of several receiving coils. The signals controlling the distribution between the four channels were caused by induction. In this way Schaeffer and Henry tried to bridge the loss of the visual feedback an instrumentalist would provide by a gestural interface for level control.

Later on, when it became common to use a conventional mixing desk for sound diffusion, the listener either can't see the performer's (hand-)gestures or, due to the arbitrary mapping on the mixing board, is hardly able to assign the gestures to their sonic results. Having this in mind, the *potentiométre d'espace* was a quite visionary and unique approach.
Evolved from the initial ideas of musique concrète, the general term 'acousmatic music' [1] emerged, coined by François Bayle in 1974. It defines music composed in the studio for a certain loudspeaker setup that is presented to the audience using sound diffusion – mostly controlled in real-time.

> *"In this context, the interface adopted for sound diffusion has been the mixing desk and the 'fader' has become the diffuser's instrument."*
> John Richards in [Richards, 2003]

The first acousmatic performance systems in the early 1970's were the *Gmebaphone* (1973) developed by the Groupe de Musique de Bourges and the *Acousmonium* (1974) by Francois Bayle and the GRM. Both were mainly stage oriented 'orchestras of loudspeakers' which consist of several 'sections' of grouped speakers. François Bayle states that the idea of the Acousmonium was largely derived *"from observing the symphony orchestra, with its standardized ordering, arranged for the best acoustic effects by groupings of instruments and levels of intensity"* [Bayle, 2007]. The composer is standing at the mixing desk, face-to-face with the loudspeaker array – like a conductor in front of a symphony orchestra.
From the artistic point of view such a system should enable the composer to interpret and reinterpret the work constructed in the studio during its live performance. Jonthy Harrison, the director of *BEAST* (Birmingham ElectroAcoustic Sound Theatre), describes this situation in such a way that *"the composer engages in a 'feedback' loop with the material and the context in which it is placed on every stage, making adjustments until the material is 'right'"*. He also initiates that with such a system the existing gestural content of a composition can further be emphasized during its live presentation:

[1] The term 'acousmatic' refers to a *"name given to the disciples of Pythagoras who, for five years listened to his teachings while he was hidden behind a curtain, without seeing him, while observing a strict silence."* (Schäffer, cited in [Kane, 2008]) The french poet Jérôme Peignot used the term in the early time of the musique concrète to describe its immanent property of hidden sources already in 1955. Twenty years later it was adapted by Francois Bayle, who defined the concept of acousmatic music that became established and widely-used.

> *"It is appropriate, therefore, that the same type of physical gesture (reinforcing a sforzando by 'nudging' the potentiometers [or faders], enlarging a 'sweep' to travel the full width of the listening space) that were used to shape material during the process of composition should be used again in performance to enhance further the articulation of the work's sonic fabric."* [Harrison, 1998]

Considering that in the most elementary case of an acousmatic performance just one stereo track is distributed dynamically to a multiple loudspeaker setup, a conventional mixing console might not be suitable for this task: Instead of summing many channels into a few stereo output signals as suitable for a studio console, a couple of input channels have to be distributed to many outputs. A straightforward solution would be to use the subgroups of the console, but in most cases there are maximally eight groups available. Another suggestion made by Harrison is to split the input channel into several stereo signals and use the direct outputs for diffusion.
Since these workarounds imply a restricted flexibility, specialized mixing equipment for sound diffusion has been developed – 'mixers in reverse' as Harrisson calls them. Since the beginning of sound projection the development of diffusion desks also reflects the current state of technology: An impressive example is the Gmebaphone which was re-created six times from scratch between 1973 and 1998. Christian Clozier, who was involved in the development, describes this process:

> *"The experience that was acquired has enabled us in the course of the elaboration of successive models to develop and refine various tools such as the interfaces and the means of accessing them, as well as the strategies of performance and analytical techniques."* [Clozier, 2001]

This attempt is especially reflected in the layout of the Gmebaphone's mixing interface: The first implementation in 1973 resembled the conventional layout of an analog mixing desk. But already in the first revision in 1975 the Gmebaphone appeared as a strongly performer-centred console in a cockpit-like, semicircular style. This design retained, with slightly variations, till the last re-creation in 1997/98.

Another aspect illustrated by looking at the sequence of its realizations is how digital technology gradually found its way into the system: The third model from 1979 already offered manual analog as well as programmable digital control of the (still analog) signal path. In the early 1980's the developers started aiming to digitize sound processing as well as diffusion. In 1990 the prototype *Ulysses* was presented as an *"initial concept for a computer-assisted audio console capable of memorizing all instrumental gestures and their variations in real-time and in concert"* [Clozier, 2001].

This concept was refined several times in the following years and led to the final version of the Gmebaphone – the *Cybernéphone* (1997) – a completely new designed digital console with two integrated control screens and digital sliders supporting up to 76 channels of diffusion.

Another system that portrays the gradual digitalisation of real-time musical performance is the *Syter* project of the GRM, which was started in 1975 by Jean-Francois Allouis. As the available processing power wasn't sufficient for real-time audio processing by far, Allouis choose a hybrid approach: In the first realization the amplitude of analog signals could be controlled digitally. With the system spatialization figures could be made during a live performance (mainly circles and fixed trajectories). François Bayle used it for the first time performing his work *Crystal* in 1977.

In 1984 the Syter system has evolved into a real-time performance and synthesis system, consisting of a real-time processor connected to a host computer. The system provided 2 inputs and 8 outputs and a graphical user interface allowing real-time control with the mouse. It is remarkable that the graphic interface closely follows the mixing-desk metaphor providing 16 virtual sliders to control different parameters as well as trigger buttons and joysticks. A prominent feature was Syter's snapshot function: Different slider settings could be interpolated enabling smooth transition between pre-arranged spatial distributions. More than 300 works has been realized using the Syter system for sound generation as well as for real-time spatialisation.

Beside the acousmatic methodology, *live electronics* are the other main approach for performing electronic music. In contrast to acousmatic music, the musical material is generated and modified during the performance. The differences in aesthetics and performance practice are characterized by composer John Richards stating that in acousmatic music *"there is a focus on textural nuance and tim-*

bral detail and the 'composition' [..] whilst in live electronics, gesture, a diversity of instrumental interfaces and spontaneity tend to shape the musical aesthetic" [Richards, 2003].

A composer who established live electronics very early in his works was Karlheinz Stockhausen: His first work using live electronics was *Mixtur* (1964) composed for orchestra, sine generators and ring modulators. The sound of five orchestra groups and several sine generators, which also were played by musicians, provided the source material for the modulators. The final realization was controlled by the composer himself operating the mixing desk: Thereby he adjusted the level and balance ratios of the modulated and unmodulated orchestra signals to form the *Mixtur* of the orchestra and its transformation dynamically. As Stockhausen wasn't completely satisfied with the transformation in *Mixtur* [Humpert, 1987, p.211], he refined this approach in his further compositions: One example is the composition *Microphonie II* (1965) for twelve vocalists, hammond organ, four ring modulators and tape. Stockhausen explained his aesthetic demands with regard to his mixing technique:

> *"During the premiere performance in the large auditorium of the Cologne Radio, I controlled potentiometers from the choir loft: according to the score I had to open or close the four speaker inputs, and thus could effect the mixture of natural and transformed sound. It is important that the transformation of the choral sound in Mikrophonie II has many gradations, that often untransformed layers are found mixed with more or less transformed layer, and that there is a transition from natural to synthetic sound, and vice versa."*
> Stockhausen cited in [Manion, 1994]

Beside this sound transformation techniques, Stockhausen used the mixing console for large-scale sound diffusion tasks. In contrast to the 'Acousmatics' he mainly spatialized live material: One spectacular example was realized in the course of the German contribution to EXPO 1970 in Osaka, Japan [Föllmer, 1996]. Already twelve years earlier a large-scale sound diffusion system was installed in the Phillips Pavillion at the Brussels Worlds' Fair designed by Iannis Xenakis: Edgar Varése's *Poéme Electronique* was distributed to 425 speakers with an automation for the sound movements. In Osaka, however, an environment was built enabling musical performances based on live electronics as well as real-time con-

trol for sound diffusion. The venue was a spherical auditorium with 30 meters in diameter equipped with 50 loudspeaker clusters, which were arranged in 7 parallel circles from bottom to top of the sphere. The speaker setup was controlled by a custom-built mixing console by Siemens Sitral. It provided seven input channels for tape playback, which were mostly used for presenting works of several composer (Zimmermann, Blacher) at daytime, and seven microphone inputs for the every evening concerts. A special, spherical interface was designed to control the spatialization providing fifty push buttons arranged in the same manner as the corresponding loudspeaker clusters in the sphere. But due to its unpractical handling it was rarely used [Föllmer, 1996]. At the suggestion of Stockhausen a circular, rotating switch has been developed enabling orbital and spiral sound movements [Winckel, 1972]. From an elevated station Stockhausen operated his concerts: Dynamically levelling the microphone signals with the faders as well as controlling the rotation patterns of the sounds. Using this setup Stockhausen and a ensemble of 19 musicians performed over a period of 180 days – an enormous musical effort being unique in live electronic music till then.

Stockhausen's preference for a circular performance setup remained in his subsequent works: From a central and exposed position the composer was shaping the sound as well as its spatial diffusion with the mixing desk. Stockhausen claimed that *"concert halls should develop in an entirely new way in the future. They should be circular, or nearly circular [..] in shape, there should be no fixed balconies and galleries for the public, but a gallery for musicians and loudspeakers"* (cited in [Manion, 1994]).

Sirius, one of Stockhausen's major works, is another examples for his spatial preferences: The piece was composed for 8-channel tape, soprano, bass voices, trumpet and bass clarinet in 1975-77, commissioned by the West German government for the United States bicentennial. The performance setup of Sirius required a round or square auditorium with two corridors in a cross-shape. At every of the four ends one performer was standing on a podium. In the remaining four segments the audience was placed facing towards the center. 16 loudspeakers were installed in a circular arrangement along the walls of the hall. At the center point of this elaborated setup the mixing desk was placed. From there Stockhausen controlled the performance combining the 8-track tape playback and the microphone signals of the soloists and the instrumentalists. Instead of the musicians, the composer at the mixing desk takes up the central position.

Stockhausen at the mixing desk – a scene that is almost a symbol of an electronic music composer being in control:
The composer as the creator of a sound universe, presenting it to the audience while taking place at its sonic epicentrum, holding the maximal control over his work by shaping the sound as well as its spacial properties.

4.2 Sounding circuits – The mixing desk as sound generator

In the previous observations the mixing desk's task was mainly to enable the composer to translate the musical material, regardless of whether it is played live or has been produced in the studio before, into the desired form according to his/her conceptions and the particular local conditions: The mixing desk is used as a realization tool for the composition.
An entirely different approach is to use the mixing desk as musical source itself: With a so-called *no-input mixer* output and input are directly connected building a feedback loop. As the output and the feedback signal are in phase a positive feedback occurs if the gain is sufficiently high. Then the output starts to oscillate whereas the oscillation frequency is determined by the resonant frequencies of the mixing desk's circuits. By modifying the system's feedback behaviour using the internal sound processing of the mixer or inserting external equipment in the feedback path, the mixer turns into a mutable sound generator.
But already long before artists like Masami Akita utilized the no-input mixer as main instrument on stage in the early 1990's, composers have traced the inherent sound capabilities of their technical equipment. Even if in the beginning the experimenting with feedback loops was an in-studio practice – its real-time approach to generate sound by 'playing' the studio differs fundamentally from analytic 'tape-construction' techniques and can be seen as precursor for the No-Input mixer as live instrument.
In 1966 Pauline Oliveros composed *I of IV* in the Electronic Music Studio of the University of Toronto. Using twelve tone generators, an organ keyboard, two line amplifiers, a mixing desk, a spring reverb and two stereo tape recorders she realized a feedback setup which enabled her to *"[play] the classical studio in real time"* [Oliveros,]. The composition process was a direct interaction with the stu-

dio circuitry, which was *"quite non-linear and required careful listening and instantaneous responses to play"* [Oliveros,]. Within six weeks Oliveros realized the pieces *I of IV, Big Mother is Watching you, Something else* and *No Mo*. Unlike in a tape collage where the source sounds are merely combined, Oliveros utilizes them to excite an interactive sound generation process directly reflecting its originating system. Doug Van Nort states that "*in listening to these pieces we are listening to the system itself and the process of the sounds becoming"* [Nort, 2006].

Another artist who deeply investigated the inherent sound possibilities of electronic studio equipment was Mauricio Kagel in his work *Acoustica*, which was realized in the WDR studio Cologne in 1969. Starting from a whole collection of complex connection schemes, he aimed to discover new and unpredictable sounds by trial and error using the studio devices beyond their technical specifications. Every individual setup enabled comprehensive control possibilities as it was characteristically for the 'semi-automated' practice of sound generation in the WDR studio. Inputs and outputs of the involved studio devices [e.g. ring modulator, filter, sine generator, (overdriven) amplifier] were connected via individual channel faders of the 16-channel mixing desk. In almost every single path of the complex schematics a fader provided a control possibility to affect the system's behaviour: The gains of the several feedback loops, the input ratios of the ring modulators, the levels of the input sources and of several splitted or summed subsignals. In this way, Kagel's electronic sound generation environments became controllable whereas up to four people where needed to 'play'. According to engineer Werner Scholz they recorded all sounds during these 'sessions' that seemed appropriate and Kagel made a selection afterwards [Morawska-Buengeler, 1988, p.51].

In contrast to Stockhausen's 'in-studio performances' as described in Chapter 2, Kagel's approach implied a much higher unpredictability due to feedback structures and non-linear transformations: The direct sonic influence of the involved electrical equipment was emphasized rather than the source signals.

In 1970 David Tudor took an important step further: Instead of exciting a system with external input, he discovered the rich musical potential of the closed loop feedback. Tudor was one of the main artists of the Pepsi Pavilion, a large-scale performance and media environment at the EXPO '70 in Osaka. For the musical performances his collaborator Gordon Mumma developed a special eight channel

console and a spatialization matrix for the 37 loudspeaker setup. Every channel of the console consists of a filter, an envelope follower, a ring modulator and a voltage-controlled amplifier [Kuivalla, 2004]. Instead of using the eight channels for several external sources as intended, Tudor reconfigured the console by patching all eight modifier-equipped channels in series and connected the output with its input. As a result varying, complex oscillator rhythms emerged:

> *"By manipulating the threshold controls to all the modifiers in sequence, rhythms began to appear and the degree of their variability was really extraordinary. (laughter) When I was performing this at the pavilion, people started to dance on the floor.."*
> David Tudor in [Hultberg, 1988]

Using this approach Tudor realized the piece 'Pepscillator', which unfortunately couldn't be recreated as it was highly dependent on the sound system of the Pepsi Pavilion. But he transferred the discovered principles to his subsequent works and soon after his crucial experience using the 'sound-modifier' console in Osaka, he developed a more general approach:

> *"most electronic equipment uses the principle of amplification. You need filters, modulators and mixing equipment which have gain stages. By piling these components up, I was able to work without any sound generators and I made several pieces in that manner."*
> David Tudor in [Hultberg, 1988]

David Tudor also developed various circuits and devices himself. The diagrams and sketches show his skills and creativity while working with electronics. An example is *Toneburst* (1975),which he composed for the choreographer Merce Cunninghamm using a large number of different devices. The prior work *Untiteled* had an even larger component count – with up to eighty devices to control it became impossible to perform the composition in real-time. Therefore Tudor was forced to record the system's output several times and using this material in the live performance together with a reduced number of devices (still forty!) [Adams, 1997]. Tudor's talent to create music by controlling complex feedback environments has once been commented by his collaborator Gordon Mumma:

> *"David developed a virtuosity in the chaotic fields between 'resonance' and 'oscillation'."*
> Gordon Mumma cited in [Hultberg, 1988]

Almost 15 years later Tudor's approach of feedback oscillation reappeared in a quite different musical background – as methodical basis of Japanese Noise Music: '*Japanoise*'.

A central figure of this genre is the Tokyo-based artist Masami Akita and his noise-project Merzbow. Akita was influenced by aggressive blues rock (Jimi Hendrix, Lou Reed, Robert Fripp), as well as free jazz (Cecil Taylor, Albert Ayler, Frank Wright). But he was also interested in the music of Pierre Henry, François Bayle, Iannis Xenakis or Karlheinz Stockhausen. His musical ambition was *"trying to create an extreme form of free music"* by *"mixing these influences into pure electronic noise"* (Akita in [Hensley, 1999]).

Akita's project Merzbow, who's name was inspired by the German Dadaist Kurt Schwitters, was founded in the early 1980's. In the beginning, Akita performed using tape-recorders and pre-produced sound material. In 1989 he started to use a no-input mixer for his live performances and from that point on most of the sound was created by mixer feedback. Beside an audio mixer, Akita just used small guitar pedal effects like delay, distortion or ring modulator. These devices were inserted into the feedback loops to shape and modify the emerged oscillation sounds – in some sense a minimized, off-the-self version of Tudor's complex feedback setups. In this way Akita produces sound masses of brute distortion, feedback, hiss and electronic squeal presented at a tremendous volume. Akita states that *"Western noise is often too conceptual and academic. Japanese Noise relishes the ecstasy of sound itself"*. He aims for a physical impact of his noise pieces as he considers his sound as 'Orgone energy', which simulates the listener bodily or even erotically[2], since for him *"noise is the most erotic form of sound"* (Akita in [Hensley, 1999]).

By forcing the mixer's electronic circuits to work far beyond their usual operating conditions, he turned the desk into an analog noise generator: Emitting a continuous blast of noise with almost constant sound level, enabling him to evoke all possible 'timbres of distortion' by modifying the signals of the feedback path – like an everlasting scream with alterable articulation.

Just a few year before Merzbow replaced his analogue setup with two laptops as sound generators, another Japanese artist started to develop mastery in playing

[2]Referring to the erotic practice of Japanese Bondage, a topic Akita is also concerned with as a writer, he released the albums *Music for Bondage Performance 1 + 2* in 1991/96 (Extreme Records) and *Electroknots* in 1995 (Cold Spring Records)

the no-input mixing board. In 1997 the Tokyo-based artist Toshimaru Nakamura experimented with guitar and mixing desk:

> *"In the course of this trial I found myself touching the guitar less and less, and doing other things with the mixing board effects more and more. I thought OK, maybe just unplug the guitar from the mixing board and try it without guitar. It's more focused."*
> Toshimaru Nakamura in [Meyer, 2003]

Nakamura became a central figure in the Japanese 'Onkyo' music scene, which came up in the late 1990's. Creating a improvisational form of electronic music, the Onkyo-related artists especially emphasize the textural aspects of sound. Nakamura's live setup resembles the one of Akita: An analogue desktop mixer with some effect processors inserted in the feedback loop. Whereas Nakamura's musical output differs significantly from Akita's: Far less aggressive than Akita's raw noise music, Nakamura uses his no-input mixer to reveal musical textures, which gradually evolve and progress, based on repetitive figures: Low, bass-like loops appear and fuse with pulsating rhythms and high frequency patterns. He creates a fine-grained texture of sound and subtly transforms it over time. Nakamura compares his method of operation with that of a sculptor: Instead of working on a solid material, he shapes feedback into sound. In the years 2000-2003 he released three solo albums, all named like his main instrument: *No-input mixing board 1-3*. Beside that, Nakamura also demonstrates the musical bandwidth of his instrument in several collaborations: From very experimental and noisy works with tabletop guitarist Keith Rowe or the no-input sampler artist Sachiko M to the much more accessible releases of Repeat – his project with the American percussionist Jason Kahn. Their works resemble a kind of ambient music, sometimes even with a glow of tonality. His preference for the no-input mixer as musical instrument is motivated by the impossibility to control the system entirely. He considers its unpredictable behavior as a musical challenge:

> *"You can't totally control no-input music. Things like turning the tuning knob even one millimeter makes a big difference in sound. [..] I'm not interested to play music without risk.""*
> Toshimaru Nakamura, Video-interview [3]

[3] The short video *No-input Sachiko M & Thoshimara Nakamura* contains interviews as well as snippets of their live performance, available at: http://www.youtube.com/watch?v=Tl8IMc-8-N8

Not just in Japan, but also throughout the world the no-input mixer has become known as an instrument for improvised electronic music: Artists like Goh Lee Kwang from Malaysia or the Croatian composer Marko Ciciliani have utilized the no-input approach for tracing the inherent sound capabilities of their mixer's circuits.

Chapter 5

Mixing Culture(s)

5.1 Energy without respite – How mixing records became a creative artistry

Since the beginning of radio broadcasting playing records alternately on two record players has been a well-established practice. Using mixing equipment like the Collins mixer described in Chapter I, the on-air announcer was able to control the volume of the record players and his microphone. In the early 1940's the term 'disc jockey' appeared, labelling the profession of announcing and playing music. Soon the operational area of the DJ wasn't just restricted to radio broadcasting: In the late 1940's the DJ entered – in the beginning just with one single record player – the ballrooms to replace the live band. In the early 1950's American Radio DJ's played at so called 'platter parties', dances organized in high school gymnasiums, mainly with the intention to make promotion for the DJ's radio show [Brewster, 2006, p.58]. Also in the upcoming nightclub scene the DJs maintained a similar role at first: Due to their perception adopting the role of a live band, they played track after track enhancing every single piece of music on its own. The main task was to select the music – as soon the needle was on the grove the actual track was played to its end without any musical intervention.
In 1968 one man radically reinvented the profession of the DJ: The New York Nightclub DJ Francis Grasso shifted the focus from playing individual songs to an overall musical performance. The DJ took over the power and became the creative leader of the dancing crowd. Especially two techniques enabled him to open up an entirely new musical potential: *Beat-mixing* and *slip-cuing*.

Being able to synchronize the beat of two records, Grasso could blend from one record to the other without a stop of the beat. In this way he was able maintain the energy on the dance floor without a break as well as extend a certain record by using two copies of it. Francis was also able to play two synchronized records simultaneously for several minutes [Brewster, 2006, p.145] – a quite difficult task considering the drummer's tempo fluctuations.
The slip-cuing technique was adopted from the radio: A felt disc was placed on the turntable reducing the friction between the platter and the record. This enabled Grasso to hold the disc without stopping the rotation of the turntable and to letting it go at the right moment.
Furthermore he was also the first DJ bringing along his own records. Before the records were owned by the nightclub [Brewster, 2006, p.142].
In 1969 he started DJing at 'The Sanctuary', a former Baptist church transformed into a nightclub. Starting as a straight club the Sanctuary soon became – as stated by Alan Goldman in his book 'Disco' from 1978 – *"the first totally uninhibited gay discothéque in America"*. The interior combined religious items with pornographic artwork and the DJ setup was placed on the former altar. From this symbolic place Grasso, utilizing his extraordinary mixing skills, created the intoxicating soundtrack for this wild scene of dance, sex and drugs. For the first time club music has unfolded its sweeping force to the whole extent – a climactic, all night maelstrom of sound carrying the crowd away without respite.
In 1969 he started to play in another club called 'Haven'. The man responsible for Haven's sound system was Alex Rosner, who pioneered the first stereo PA system in a nightclub. Due to their origin in broadcasting, all DJ mixers used by then had been mono. Therefore Rosner developed the first stereo DJ mixer for the Haven, which was immediately occupied by Grasso to augment his creative performances. Although this small mixer called 'Rosie' (because of its red paint) was quite simple, it contained a technical novelty: The cueing system. Beside the three volume sliders for two turntables and one microphone, the mixer had a tri-state toggle switch. With this the DJ could select one of the three input sources which then was routed to his headphones. In this way he could pre-listen the next song and prepare the next mix. The cuing system immediately became a main feature of a DJ mixer. From today's point of view it is hard to imagine mixing 'beat-to-beat' without the help of pre-listening, as Grasso did in the beginning. As Rosie was a custom built device and Rosner was not happy about its quality

either, he contacted Louis Bozak, a manufacturer of mono mixers for broadcast uses and PA systems, telling him that *"what's really needed out here is a stereo mixer, because stereo is the way to go"* [Rosner, 2003]. Rosner advised Bozak how to modify his existing mixer design to turn it into a stereophonic DJ mixer. With the help of Richard Long, who designed the PA systems of such legendary New York nightclubs like the 'Studio 54' or the 'Paradise Garage', they developed the first manufactured, stereophonic DJ mixer, the Bozak CMA-10-2DL. The mixer provided one mono and five stereo inputs (3x phono, 2x aux, 1x mic) with volume and balance control, a cueing system, and a two band equalizer for the stereo output. As all controls were implemented as rotary potentiometers and due to its 19 inch/4U rack housing the Bozak looked vaguely similar to early days radio mixers. The development was an instant success – from its debut in the beginning 1970's throughout the whole decade the Bozak CMA-10-2DL was the industry standard for club installations. It became a status symbol for DJing in the disco era supporting Grasso and his fellows to supply the dance floors of New York City with non-stop energy.

5.2 The sound of the Bronx: Mixer and turntables as musical instrument

At the same time – far apart from the sparkling mirror balls and fancy interiors of the New York downtown nightclubs even so locally just several kilometers away – a new musical movement arose which should bring the creative artistry of mixing records to another level.
In the Bronx the Jamaican-born Clive Campbell, called DJ Kool Herc, discovered, when playing on block parties, that many dancers waited for particular breaks in the records. These breaks were mainly drum solos from up-to-date funk records. So Herc started playing a sequence of these breaks, leaving out the rest of the records:

> *"I said let me put a couple of these records together, that got breaks in them. I did it. boom bom bom bom. I try to make it sound like a record. Place went berserk. Loved it."*
> DJ Kool Herc in [Broughton, 1998]

Herc used a small silver mixing unit, a GLI 3800 mixer – the first product of the Brooklyn-based company GLI. As the Bozak mixers were built as discrete, solid-state devices ensuring the best possible sound quality, they were extremely expensive and just affordable for the prosperous nightclubs. Therefore companies like GLI or Gemini started to offer cheaper alternatives reacting on the increasing demand. Besides lower prices, also another feature found its way into DJ mixing gear: The *crossfader*. This slider enables the DJ to blend from one to the other record within a single move. On mixers like the Bozak, offering just separated volume controls, a two-hands operation had been necessary. From the performer's perspective this new feature allows a much easier handling. In addition to that, the other hand is free – the basis for handling mixer and turntable at the same time. As the first implementations of the crossfader (which has its roots in the broadcast industry) were based on the assumption that the two input signals are statistically uncorrelated, just a minor modification of the common panning circuit was necessary to make constant energy fading possible [Jeffs, 1999]. However, this basic assumption was not true for disco music: Blending two synchronized, beat-dominant disco tracks, which can't be considered as incoherent signals, would lead to a boost of their sum. For this reason as well as due to the demands of the various upcoming mixing techniques, several different crossfader curves have been established: Cutting in one channel without affecting the volume level of the other, cutting in one side and continuously increase its volume ('pump it up') or providing a sharp cut to the other channel. In this way the crossfader evolved from a 'standardized' artifact to an expressive tool suited to the artist's particular demands.

Deeply impressed by Kool Herc's DJ gigs in the Bronx the Barbados-born Joseph Saddler decided immediately to become a DJ himself. Although he loved Herc's approach to play a sequence of breaks to the joy of the dancers, he disliked his sloppy mixing skills as Herc was not able to accomplish clean beat-to-beat mixes. His second source of inspiration was DJ Pete Jones, a leading DJ of the black disco movement, who mastered the same mixing techniques as Grasso and his fellows in the downtown's underground clubs, but showed them to a broader audience, including the party-goers in the Bronx [Brewster, 2006, p.236]. Combining these approaches, Saddler, who soon would call himself Grandmaster Flash, sets

his sights on mixing "breaks"[1] of records in time keeping up the beat. For lack of a DJ mixer Flash used a Sony MX8, a simple 6 channel microphone mixer, in combination with two external pre-amps to bring the signals of the turntables to line level. Furthermore he realized a simple cuing system using a double throw switch glued to the mixer's top, allowing him to pre-listen both input signals [Brewster, 2006, p.238]. Quickly Flash developed enormous skills in handling his mixing setup: He was able to perform beat-to-beat mixes with an astonishing speed: But instead of repeating a whole passage to extend a track like Grasso, Flash cut a track into very short sections allowing him recreate the song's structure. His quickness results from the disregard of the convention not to touch the playing records: While the volume is low he would spin back the corresponding section to repeat and toggle between the records with the mixer's volume sliders (and vice versa). This technique enabled him to chop up and rearrange his source material in a rapid sequence without loosing the beat. Touching the records to brake, speed up, spin back or clutch them, combined with exactly coordinated actions on the mixer, opened up a variety of new techniques. At that point, turntables and mixer fuse into a real musical instrument, offering various options for musical expression while demanding a musical sense and highly dexterous skills from its player: The actions are fast, mostly two-handed, and performed in rapid succession – most likely no one before him handled a mixing desk in such a fast and drastic way.
Playing in small clubs at first, Flash soon became famous in uptown New York. In 1981 Flash released the record *Adventures Of Grandmaster Flash On The Wheels Of Steel* – a seven minute DJ mix combining highly danceable tracks of artist like Blondie or Queen with the first tunes of the up-coming hip hop genre spiced up with some movie samples.

> *"It took me three turntables, two mixers and between ten and fifteen takes to get it right."*
> Grandmaster Flash in [Brewster, 2006]

For the first time a record was entirely based on already released material. This caused a focus shift as no longer just the musical content, but most notably *how* the music was presented and combined was the crucial factor. The hip hop DJ be-

[1] The term "break" refers to an instrumental section of a song that is mostly reduced to drums and percussion only (also: "drum break").

came a ‘macro-instrumentalist’ using already existing material to create a unique musical performance.

Also the signature sound of pushing and pulling a record back and forth – well known as ‘scratching’ – is heard on Flash’s mixing record, captured on vinyl for the first time. This technique was discovered by Theodore Livingstone, a DJ from the Bronx naming himself Grand Wizzard Theodore, and was enhanced by Grandmaster Flash. Scratching has further extended the possibilities of expression as it enables the DJ to actively produce sounds related to his used material - setting rhythmical accents or highlighting musical phrases. From the simplest form of scratching performed by spinning back and forth a record while the channel is assigned to the mixer’s output with the crossfader (‘Baby scratch’), a comprehensive repertoire of complex scratch methods and techniques has evolved. The most virtuosic and radical progression arose from the turntablism movement in the mid 1990’s, a sub-genre reclaiming the DJ culture of hip hop, at a time when hip hop was already part of the musical mainstream. The DJs compete with each other performing elaborated routines demonstrating their technical virtuosity and musical creativity in a highly condensed, short-time DJ set. Developing more and more complex matched mixer/record manipulations, they further expanded the musical possibilities of their instrument: Ranging from mimicking musical effects like tremolo, vibrato, reverse or echo sounds to playing whole melodies by chopping a sound and controlling the pitch of each segment via rapid adjustments of the playback speed. The turntablist uses his mixing setup as a expressive instrument similar to a solo musician who artfully interweaves several pieces – each flaring up just for a moment – to a dense, overall performance.

In summary the development of DJ mixing had a crucial impact on nowadays music culture: Forty years after Schaeffer mixed records to realize his first compositions Afro-American DJs revitalized the creative combination of recorded material as musical technique that should strongly influence the upcoming musical genres. The manual looping technique was a precursor to today’s variety of loop-based musical styles as well as for sampling and re-mixing. Or as the British music journalist Jon Savage puts it: *“What is sampling if not digitized scratching?”* [Savage, 1993] The freedom of mixing records with different local and musical backgrounds speeded up their distribution and enabled an intercultural exchange of popular music: It is reported that Africa Bambaataa, another hip hop pioneer, used to play Kraftwerk’s *Trans Europa Express* superimposing a record of a Mal-

com X speech [Brewster, 2006, p.264]. Imagining an Afro-American party crowd somewhere in the Bronx of the late 1970's dancing to the stoic, machine-like beat of the German synthpop pioneers overlaid with flaming phrases of the civil rights activist Malcom X, who was killed more than 25 years earlier, impressively illustrates the creative potential of this radical musical fusion.

5.3 Hi–tek soul: A mixture for the dance floor

Evolving from the disco culture of the late 1970's, a new approach to dance music arose in the early 80's: Instead of mixing the most danceable sections of available funk, soul and disco records the DJs started to produce music by themselves. The turn of DJs becoming active music producers was the initial spark for the rapid development of electronic dance music in the following years. The protagonists tried to transfer musical spirit of soul and disco into a new sound exclusively made for the dance floor. House music, emanating from the black clubbing culture of Chicago, defined the new musical rules: An up tempo, four-four time beat driven by a predominant bass drum and a distinctive synthesizer bass line combined with vocals, sound effects and percussion referring to its musical roots in soul, funk and disco. In Detroit European electronic sounds fused with the reverberant vibe of black club music into an even more reduced, impulsive dance music which should become known soon as 'techno'. Derrick May, one of the founders of Detroit techno, describes the music as *"just like Detroit, a complete mistake. It's like George Clinton and Kraftwerk stuck in an elevator"* [Savage, 1993].
Starting as a underground phenomenon, early dance music producers didn't have access to state-of-the-art studio equipment: The setup, mostly consisting of an analog mixer, an analog drum machine and some synthesizers, contrasted with the technical facilities of the booming high-end recording studios at that time. To realize their vision of sound they had to tap the full potential of sound generators and mixing desk. The Detroit techno pioneer Juan Atkins stated:

> *"I don't just use a [mixing] desk to mix sounds together. I use it as a creative tool..."*
> Juan Atkins cited in [Snoman, 2009]

Even if the following statement of the German producer Johannes Heil was made ten years after techno's birth in Detroit referring to his releases in the late 1990's,

it illustrates the creative scope of working with such a reduced equipment:

> *"In the beginning I had a Novation BassStation, my sampler and a little Samson mixer with fixed frequencies – with these I wanted to realize a hard and crazed sound. [..] then I pushed the mixer till it developed an internal dynamic. Then it sounds like a compressor, it swallows and chokes and produces a lot of feedback. [..] I experimented until it sounded really sick and then I recorded it. Of course 20 DAT's are bullshit, but two tracks are just amazing."* [2]
> Johannes Heil in [Gebhardt, 2001]

Most artists of the rapidly growing electronic dance music scene acted as DJs as well as producers. Therefore it's reasonable that their experience of mixing music as a DJ affected the way they worked in the studio, especially as this approach is reflected by the structure of the music itself: Clearly fragmented into particular, repetitive layers a track can be intuitively arranged at the mixing desk. A good example how DJing can influence the production workflow in the studio is given by German techno producer Heiko Laux:

> *"If I'm recording I make my mix directly in the subgroup, arranging directly at the mixing desk. I mix the single elements of a track like I play records as a DJ. While I am recording I also try to capture a bit of spontaneity. [..] Once I press stop at the DAT recorder or the computer the track is finished."* [3]
> Heiko Laux in [Gebhardt, 2000]

5.4 Dub music: Jazz at the mixing board

Already many years before the rise of electronic dance music, spontaneity and virtuosity at the mixing desk even became the artistic essence of a whole musical genre: Dub music, which started evolving as a sub-genre of reggae in Jamaica in the early 1970's, was mainly created by improvising at the mixing desk and should influence several genres of dance and pop music.

[2] The original quote (German) has been translated by the author
[3] The original quote (German) has been translated by the author

The central figure in the development of Dub was the 1941 born Osbourne Ruddock, who earned his money as an electrician by repairing radios and TV sets at first. Since the 1950's, mobile sound systems were common in Jamaica enabling impromptu dance parties on the streets. At the begin of the 1960's the sound system operators were playing ska and rocksteady music which would evolve into reggae in the middle of the decade. Utilizing his remarkable skills as a radio electrician Ruddock set up his 'Home Town HIFI' sound system which should soon become famous outclassing his competitors' systems in terms of performance and sound quality. The key finding for the origin of dub music was that intensifying the rhythmical content of known tracks aroused wild enthusiasm if these versions were played on the sound system. This was achieved by leaving out some of the vocal parts during a new mixdown in the studio. When presenting such versions Ruddock – called King Tubby – additionally modified them with reverb and echo effects which were unique for his Home Town HIFI sound system [Brewster, 2006, pp.110]. To further pursue this approach he set up a small home studio consisting of a home-built mixing console, some self-made effect units, a four and a two track tape machine and an acetate disc cutter [Veal, 2007, p.112]. Starting to experiment with these instrumental edits, he developed elaborate effect routings enabling him to create drastic sound effects like escalating cascades of delays or dynamic reverbs. He controlled the effects via the channel faders of the mixing console. Besides that, he dynamically controlled the sound levels of the several tracks during the recording. The British writer and reggae producer Steve Barrow characterizes the production process as follows:

> *"Improvisation was the order of the day; most of Tubby's dubs were mixed live, with the engineer playing his board like a great jazzman blowing solos on his horn, deconstructing and reinventing the music."* [Barrow, 1995]

Working with such notable reggae producers like Lee Perry or Bunny Lee enabled him to expand his studio: He bought a mixing console from Byron Lee's Dynamic Studio – a four-channel desk from MCI, custom-built by Grover C. Harned, the founder of MCI [Veal, 2007, p.113]. Phillip Smart, one of his disciples, suggested that 'Tubby'replaced the original faders of this board with ones that were more smooth-running in order to enable faster and more fluid level and effect manipulations. Lloyd 'King Jammy' James, another producer who joined Tubby's team in

1976, explained the resulting benefit in practice:

> *"..we could rout [sic!] any effect to the faders and do it manually, so we could control the rhythm of it."*
> Loyd James cited in [Veal, 2007, p.114]

Another technical feature of the MCI console, which was utilized by Tubby in a unique way, was the built-in high-pass filter. Ranging from 70Hz to 7.5 kHz the filter could be controlled with a big knob at the right side of the desk. It was used for sweeping sound effects on drums, bass as well as on vocal tracks. Tubby even created his own trademark sound that has influenced the whole genre: His dynamical filtering of the 'flying cymbals' sound, a newly appearing drum pattern inspired by American disco and soul records, sparked Jamaica's music scene as well as boosted his business:

> *"Everybody had to come there to mix their sound to get that effect, 'cause no other console had that. Everybody was saying 'Boiw [sic!], make sure that you put that sound in it!"*
> Loyd James cited in [Veal, 2007, p.115]

Due to his creativity King Tubby soon became one of most influential producers in the Jamaican scene. Despite his dramatic death – he was shot down in 1989 in front of his newly built studio – many of his musical techniques found their way into today's pop music production. The distinctive sound characteristics of Dub music became significant for several styles of electronic dance music. Dub established the practice of remixing existing material in the studio as a form of artistry that should become an inherent part of the popular music culture.

The extraordinary approach of this musical genre is the explicit will to create: With a minimum of equipment its protagonists tried to achieve a maximal musical outcome. The mixing desk is used as an instrument for encouraged musical intervention and creation instead of cautious fine tuning. The spontaneity and improvisation at the mixer during a recording contrasts with the total control in nowadays digital production chains. This raises the question if the musical value of this direct-access approach can entirely be compensated by the current production methodology which has committed itself to perfect reproducibility.

Andrea Terrano, a producer discovering dub music in the early 1990's, reflects how dub affected and redefined the understanding of his role behind the mixing desk:

“For the first time ever in my working career as a sound engineer, I was aware of the creative central position that I occupied when mixing dub. It was as if the mixing board became a real musical instrument. I was a performer and my skills on the desk were the center of attention. When you are mixing dub you are the driving force and you are expected to perform” [Terrano, 2007].

Chapter 6

Mixing in Zeros and Ones

6.1 From analog to digital

The mixer's transition from the analog into the digital domain was a gradual process: During the 1970's digital technology found its way into professional audio applications. But as the performance was still too low for real time audio processing, digital circuitry made its appearance in mixing technology implementing VCA-based automation and dynamic control [1]. In 1977 Solid State Logic (SSL) released its SL 4000B console with VCA dynamics in every channel and a computer controlled automation system. In the same year Neve expanded the analog console of London's Air Studio with the first motorized fader system (NECAM: Neve Computer Assisted Mixdown).

During the 1980's all state-of-the-art mixing desks featured an analog signal path combined with comprehensive digital control: High priced, large-format hybrid consoles customized for the recording industry being in its golden decade.

Even though Neve introduced the first commercial digital audio mixer DSP-1 at the begin of the 1980's, it had no significance on the market. This was not about to change until Neve introduced the *Logic* series ten years later followed by the first large-scale digital music console *Capricorn* in 1993.

Even if the transition from analog to entirely DSP-based mixing systems can be seen as a big technological leap, its impact on artistic creation was fairly restricted: Solely big commercial recording studios and broadcasting cooperations

[1] In contrast to previous voltage-controlled amplifiers instead of an analog control voltage a digital signal was used to control the amplifier's gain.

could afford digital mixing technology in the early 1990's.
In 1994 this situation changed when the Yamaha Cooperation released the ProMix 01, a compact, 18 channel digital mixer for a competitive price of less than $2000. But even if the ProMix01 made digital mixing affordable, analog mixing technology still maintained its important role in the creative process: For many artists and smaller studio facilities products like the first 'affordable' analog 8 bus console, which was released just one year earlier by the Mackie Company, were more valuable from a practical point of view. At the same time it became evident that due to the available computational power more and more audio processing tasks could be directly performed with the computer – a development that should radically change the process and the conditions of music production.

6.2 Mixing becomes virtual

When the first software for midi sequencing appeared in the mid 1980's, the personal computer entered the studio. Over the next years these programs gradually evolved and audio recording and processing features were integrated. At least since the built-in, virtual audio/midi mixer became a standard feature and the audio processing could be performed by the native hardware only, the transition to the virtual studio was fully accomplished. The impact was sweeping: The recording industry suffered the loss of its monopoly on high quality audio production – a fact that should cause the bankruptcy of many commercial studios during the 2000's. Also many manufactures couldn't adapt fast enough to the new market situation: By way of example SSL, one of the leading manufacturers of large-scale production consoles, ran into serious financial problems. The company was purchased in 2005 and the new owners – among them musician Peter Gabriel – immediately changed the strategic direction: Releasing more favorable products that could be seamlessly integrated into the digital studio environment.
On the other hand the home studio started it's triumph: In the mid 1990's programs like Cubase VST enabled its user to record, process and mix 32 audio channels using an off-the-shelf computer. The rise of digital audio workstations 'democratized' the audio production and changed the established role allocation: Now musicians have the possibility to act as their own sound engineers and the distinction between composer, producer and musician is not explicit anymore in

the digital studio.

6.3 Mixing in a digital world

Beside the technological and sociological impact of mixing becoming digital, it seems especially worth to reflect how this change affected the creative approach towards mixing technology. How adapted artists their techniques according to the new conditions? What kind of creative possibilities emerged from this radical shift in technology?

In the mid-1990's the emerging computational power enabled the development of real-time audio processing languages, that should strongly affect the composition and performance practice in electronic music: The real-time implementation of Csound[2] or programming environments like Max/MSP[3], PureData[4] or SuperCollider[5] combined recording, audio synthesis and signal processing with real-time control. This opened up entirely new opportunities for composers: Now they were able to easily realize their own musical tools for composition and live performance.
It became a common sight that electronic musicians play on stage just with a computer that directly outputs the musical result. The process of mixing happens somewhere within the self-created environment – sometimes not even implemented as a distinctive stage. Sound generation, manipulation and mixing are often closely merged. As the final mix may depend on several parameters at different stages the artist performs a free form of 'mixing in progress' according to her/his actual real-time environment.
For live sound diffusion the mixing console is still relevant as a physical control

[2]Csound is a C-based programming language for audio, initially written in 1985. In 1990 Barry Vercoe and Dan Ellis of MIT presented a new version for real-time operation [Vercoe, 1990] (http://www.csounds.com/) (accessed: 29.05.2011)

[3]Max/MSP is a visual programming environment for music and multimedia. It is a commercial software distributed by the company Cycling '74. (http://cycling74.com/)(accessed: 29.05.2011)

[4]Pure Data is a graphical, open-source, real-time programming environment for computer music, audio, video and graphic processing. The programming language has initially been developed by Miller Puckette at the IRCAM. (http://puredata.info/)(accessed: 29.05.2011)

[5]SuperCollider is a programming language and environment for real-time audio. It's a free software released in 1996 by James McCartney and has been further developed over the years (http://www.audiosynth.com/)(accessed: 29.05.2011)

interface. The implementations range from entirely computer based applications with external hardware control to customized DSP systems. Also digital live or broadcast consoles have been adapted for sound diffusion tasks. Although all these systems are implemented in the digital domain it seems that they still mimic established paradigms. Even if new technical features were added, it appears that many of them just augment the common characteristics of a traditional mixing system instead of enabling far-reaching, new approaches.
This discrepancy is illustrated by Karlheinz Stockhausen using the example of the motor fader:

> *"We had a mixer by Lawo and we could change the volume relationships of up to 24 channels relatively quickly with an electronic programmer. [..] and the faders could go up and down one after the other very quickly. How that was mechanically possible very often surprised me. However, that's where I had to stop. And this is something I would very much like to develop further: that in a space filled with speakers all around the audience, sounds shoot out of the wall with different speeds, very quickly following each other [..] So this shoots onto the listener continuously using different dynamic levels for each event, I really have to try this out some time; I really want to. So, the dynamics are very weak nowadays. We control envelopes just as in traditional music. "*
>
> Karlheinz Stockhausen in [Bruemmer, 2004]

In popular music computer-based production gave rise to an enormous musical diversity: Be it electronic dance music, hip hop or independent pop or rock music – from now onwards high production quality could be attained with a minimum of expense. Digital Audio Workstations offered all recording and editing possibilities which were reserved for professional studios before. As the mixer was directly integrated into the software, hardware mixing became much less important: The new generation of producers was ready to go 'mixer-less'.
Its remarkable that the integrated DAW mixers should appear as an almost photo-realistic reproduction of the traditional mixer interface. Due to the restricted interaction possibilities the first control surfaces came up in the early 2000's trying compensate the lack of haptic access.
The technological change has also affected DJ mixing: Digital DJ programs ap-

peared turning a conventional laptop into a tool for playing and mixing digital audio files. The advent of digital DJ mixing divided the scene in two opposing camps: The one immediately utilized the new possibilities allowing them to access and take along a giant music collection stored on their laptop's hard drive as well as easily integrate their own or unreleased music. The other refuses digital mixing due to the lack of tactile control. Furthermore technical features like automatic track synchronization are criticized for endamaging the artistry of DJing. The latter argument rises the question why someone who is able to synchronize the tracks manually should be a better DJ categorically? Should not the overall musical result be crucial ?

In order to combine the tactile quality of vinyl with the advantage of digital playback, several hybrid systems appeared enabling the DJ to mix and control digital audio files with a traditional setup using an external audio mixer and normal turntables. With the help of particular records containing a digital time code, the playback of the audio files can be controlled according to the DJ's manipulations at the turntable[6]. Beside that, tools like the handheld-sized music player and mixer Pacemaker[7] or the variety of mixing application available for smart phones and other mobile devices show that DJ mixing has become ubiquitous these days. Released in 2001, the loop-based audio sequencer software Ableton Live[8] started to blur the lines between DJing, remixing and producing: Its loop-based approach enables to edit and remix any source material which will be synchronized to the master tempo automatically. Instead of playing track after track in a linear progression a DJ can play several song snippets simultaneously and arrange them in an arbitrary order. The DJ is becoming a live remixer able to create new musical material on the fly by mixing looped audio files of any kind. On the other hand the software is used for arranging and producing in the studio allowing the artist to present the music live in a flexible way without being constrained to the timeline.

The remarkable fact that both DJs and producers are using the same software alike, illustrates that the boarders between mixing music and making music have almost disappeared in today's popular music culture.

[6]Examples: Rane Serato Scratch (http://serato.com/) or Miss Pinky (http://www.mspinky.com/) (accessed: 29.05.2011)

[7]Product page: http://www.pacemaker.net/ (accessed: 29.05.2011)

[8]Product page: http://www.ableton.com/ (accessed: 29.05.2011)

Chapter 7

Conclusion and prospects

7.1 70 years in a nutshell

Covering a broad spectrum of entirely different musical genres over the past 70 years, this text is aimed at shedding light on the audio mixer as a creative tool from different angles of view.
According to its basic functionality, it is not surprising that we've often found the mixer occupying a central position in the process of musical creation. But the way *how* different composers and musicians have used the mixer as a catalyst for their musical visions opens up varied perspectives:
One interesting aspect is that in entirely different musical genres and contexts the mixing desk has gained an instrument-like status: For Kagel's or Stockhausen's elaborate in-studio compositions several *"players"* or *"musicians"* were needed, reffering to acousmatic performances the mixing desk is characterized as *"the diffuser's instrument"*, or a Dub producer is said to play *"his board like a great jazzman"*. But beside this terminology, also practical comparisons can be drawn: The dexterity needed to perform a complex turntablism routine is well comparable to the one required to master a musical instrument. The no-input approach can be seen as a form of musical improvisation: Instead of improvising with a traditional musical instrument, an artist playing the no-input mixer is interacting with a complex feedback system and will hardly be able to reproduce a distinctive musical event: The sonic reaction of the nonlinear system calls for a fast response of its player – a call and response process emerges where improvisation is the need of the moment.

In most cases the mixing desk isn't the instrument by itself. It becomes a musical instrument by establishing a 'symbiosis' with further devices: Whether it be the turntable of a Hip Hop DJ or the outboard equipment in case of an in-studio composition, the particular conditions of use define the characteristics of the resulting musical instrument. A notable exception is the development of electronic sound synthesis: Mixing unit and sound generators have been combined into a standalone, musical instrument – the synthesizer.
Another aspect is the interplay between artistic needs and available technical features: On the one hand inherent features of the mixing desk have been used for purposes other than intended: Sub-groups or direct outs have been utilized to turn a normal mixer into a diffusion desk, or the no-input approach creatively 'misuses' the whole device as sound generator. On the other hand we have discovered examples where the mixer has been highly adapted to the artistic demands: Beside the several specialized diffusion consoles, the DJ mixer is a vivid example for a highly customized modification of the mixer prototype establishing a separate sub-category. Especially the DJ crossfader, evolving from a 'standardized' to an individual component supporting the artist's very particular demands, illustrates this adaption process.

7.2 The future of mixing?

Following the development from the vacuum tube to an audio mixer embedded in a smart phone creates the impression that the mixer's technical progress has always been driven by the latest technology. This is at least true for the implementation of the mixer's functional parts. But do we tap the latest technology's potential to refine the audio mixer as a creative tool by exploring new possibilities of musical interaction?
The majority of today's mixing applications adhere to the interface paradigms of a traditional mixing desk: A common software mixer emulates the analog interface of its physical precursor – even though the conditions of interaction differ significantly in software. Also hardware interfaces are no longer restricted to the traditional mixer layout, as this was mainly determined by the technical properties of its electro-mechanical components. Since the functional core of today's digital mixing systems is fully separated from the user-interface, we gain unrestrained

freedom for its physical design.
With reference to the creative use of mixing technology, I claim that there are several alternatives to the traditional mixer layout supporting particular artistic objectives. In this sense, I think it is helpful if audio mixing isn't categorical connected with a specific technical artifact. Instead, it may be beneficial to reflect about the *concept of mixing sound* in a more general way. Today's technology offers many opportunities for entirely different approaches: Using tangible user interfaces (TUI) or multi-touch technology, we can overcome several constraints of the established mixing paradigms: An example would be a mixing environment that addresses multiple users enabling a playful, collaborative musical interplay. The same kind of technology could also be used to visualize the process of mixing in a more comprehensible way: By applying good metaphors, a mixing interface for live performance could provide an extensive, creative scope for the performer, but being understandable for the audience as well[1]. Another scenario would be a player controlling a mixture of sound with certain gestures or movements. Also by tracking several people's positions in a room, multiple sounds could be controlled creating a collaborative, sonic environment.

Indeed, alongside these mentioned scenarios as well as many others, the traditional mixing desk hasn't lost its relevance in musical composition and performance – but its good to know that we have more possibilities than ever to realize our own particular visions of mixing sound in a way that inspires us when making music.

[1] As a very first approach, I developed a basic prototype of a tangible mixing interface following the metaphor of acoustic sources. This provides a coherent representation of the spatial properties while supporting multi-parameter input. For detailed information see the Scope project page at http://www.benbengler.com/developments.html (accessed: 13.06.2011)

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