Chapter 4 – Cultural Resonances

The ecological perspective presented in the previous chapter demonstrates that our perceptual and cognitive systems may be the result of an adaptation process, and the need to act in the environment in order to survive may be seen as the driving force behind this adaptation process. Most people would probably agree that the influence goes both ways—we also shape our environment according to our worldviews. This is evident, for instance, in the architecture and infrastructure that surrounds us. The integrated pattern of human knowledge, beliefs, values, social forms and behavior in a given environment is referred to as culture, as opposed to nature. Leman (2007) describes the interplay between natural/biological and cultural forces of influence as a resonance system in which our understanding of the world and our ability to act accordingly is constantly challenged. In this chapter, I will look at how our view of music undergoes change as a result of technological advances, and argue that aspects of our musical culture at the moment may be out of phase with the rapid technological development.

4.1 Natural and Cultural Constraints

In chapter 3, we were introduced to the term affordance. Gibson (1979) defined affordances as “action possibilities”. This definition implies that we seek out opportunities to act amidst a constant sea of limitations. The limits imposed upon us as acting organisms may be referred to as constraints (Leman 2007). Natural constraints subsume the laws of physics and biology, and form the study domain of the natural sciences. In addition to natural constraints, human action is also guided by what is acceptable, appreciated, and considered to be true or valid in a culture (ibid. 55). These rules, or domains of knowledge, can be referred to as cultural constraints, and underlie the study of human sciences. Historically, music has assumed an ambiguous position in between natural and human sciences. For example, music was taught as one of the four disciplines in the quadrivium (arithmetic, geometry, music and astronomy) in European mediaeval universities, as opposed to the three disciplines in the trivium (grammar, logic and rhetoric) (Kjerschow 1993). Over the course of the past few centuries, music as a discipline has drifted toward being
regarded as one belonging under the umbrella of human sciences. However, the development of musical instruments, and the ongoing development of music technology, demonstrates the interdisciplinary nature of music.

Both natural and cultural constraints exert influence on the development of musical instruments (Leman 2007). Natural constraints include the availability of materials in the environment, tools (technology) with which instruments can be constructed, and the physiological and cognitive capacity of human performers. Cultural constraints may be the type of timbres, musical scales, rhythm structures, musical styles and musical habits preferred by a particular culture. Natural and cultural constraints interact continually in a complex manner, making it difficult to account for the diversity of musical cultures around the world. What is clear, however, is that the musical instruments of a particular culture, and how they are used, often reflect the musical preferences of the same culture. For example, most instruments in Western culture are constructed in such ways that harmonic resonances dominate over inharmonic resonances, which may be seen as reflecting the preference in Western culture for harmonic sounds in music. Other cultures, such as the Indonesian culture, seemingly prefer instruments that produce inharmonic structures (Sethares 1998). The question of why different cultures develop different musical preferences is not an easy one to answer. Leman (2007) suggests that cultures develop in resonance with particular natural constraints. Cultural constraints emerge when trends based on natural constraints solidify into cultural paradigms, and appear to be detached from their original natural environment. The tritone interval in music is a case in point. Due to the physiology of our inner ear and auditory cortex, the tritone is the interval where the number of frequencies competing within the same critical bandwidths is the highest, which causes a high degree of perceived roughness (Rossing et al. 2002). In medieval European church music, roughness (dissonance) became something to be avoided, because music was supposed to have a serene character in order to serve the function of worship. Perhaps because of its particularly restless character, the tritone was labeled “the devil in music” (diabolus in musica). The “forbidden” tritone was a cultural constraint in Christian music for centuries.
A full-blown introduction to theories about how resonances between musical preferences and musical instruments of different cultures may have originated is beyond the scope of this thesis. Here, I will limit myself to highlighting the importance of technological advances in the development of musical cultures. Historically, new technologies have created new musical affordances. New affordances may appear in the wake of particular natural constraints that have ceased to exist. For example, the emergence of pipe organs that could be played with keyboards (*manuals*) afforded polyphonic performance by one person on a level hitherto impossible, due to the natural constraints of instrument design and human physiology. However, the appearance of new affordances are not necessarily recognized by a culture, because cultural constraints that have developed in resonance with natural constraints may have become so pronounced that a potential new affordance starts out as a “no-go area”. An example is the minimization of amplitude distortion for several decades after the invention of electronically amplified instruments. Distortion was simply not deemed musical. Rock and electronic music gradually changed this view, to the effect that many musicians now view distortion effects as things which offer, among other things, particularly powerful expressions of affect. Ogburn (1957) coined the term *cultural lag* to describe the notion that culture takes time to catch up with technological innovations. I think such lags between technological advances and cultural constraints may be seen as brief periods where cultural constraints are out of phase with natural constraints, in a relationship otherwise characterized by resonance. In such contexts, so-called experimental or avant-garde musicians play an important role in investigating potential affordances in new technologies. The experimenting may be seen as an orientation toward new media, where the goal is to find ways of expressing oneself truthfully and with relevance in an ever-changing environment.

In a parallel process, but on a completely different time scale, organisms adapt to their environments, as described in Chapter 3. I find the comparison between evolution in nature and development in culture interesting, because in many ways, the two processes may be regarded as mirror processes. Figure 4.1 shows a diagram demonstrating these mirror processes. In my visualization, technological inventions have a function in the development of the arts (including music) similar to the
function of biological mutations in the evolution of life. The concepts of natural and cultural constraints are represented here as forces of influence upon biological and technological processes. The main reason behind representing the processes in this way is to demonstrate that biological mutations and technological inventions can create new affordances which may take time to be discovered—the creation of affordances is not necessarily planned. In the case of evolution, the time scale for adaptation may be thousands or even millions of years, whereas the time scale for orientation toward new media in the arts may be years or decades.

Figure 4.1. A diagram demonstrating the mirror processes of evolution of life and development of the arts. The diagram is my own representation of natural and cultural forces of influence upon biological and technological processes, resulting in the evolution of life and the development of culture.
In the case of digital technology, the amount of new musical affordances may be larger than most people realize. A great number of natural constraints have simultaneously ceased to exist, but many of the cultural constraints that have developed in “resonance” with these natural constraints are, for the time being, held in place. For example, the concept of music as composed and performed by humans is being challenged by the existence of virtual composing environments, where the software can be seen as composed by a person, but the music itself is not (Jordà 2005). Before the age of digital computing, it was less common to think of music as something that could materialize without being composed and/or performed by people. However, even now that computers afford music composed and performed by machines, it seems that many people are not willing to accept this as “real” music. The fact that the composed software may be seen a form of human artistic expression may not make a difference to many people.

Other natural constraints that have disappeared as a result of digital computing have to do with the physiological limits to the amount of individual sounds a performer can make with the instrument. In DMIIs, there are virtually no limits. In many cases, an audience without any working experience with DMIIs has no chance of detecting the virtuosity of a DMI performer, because virtuosity does not necessarily lie in the sequencing of notes or in dynamic/timbral fluctuations. In fact, the audience cannot know anything about the performance for certain, or even if it is a performance at all—it could all be preprogrammed. In order to relate to a live DMI performance, I think that the audience must either know the program that the instrument is running, understand how the program works, recognize at least some of the algorithms or functions used in the program, or witness consistent relations between the performer’s actions and the sounds coming from the instrument. Hence, the concept of virtuosity faces challenge, and the DMI performer often assumes an enigmatic role in the minds of the population at large. I believe that traditional views of music and the lack of education about the musical possibilities offered by digital computing may be feeding back into cultural constraints, leading to the excessive development of DMIIs oriented toward existing genres, styles and traditions instead of instruments pointing toward potential future areas of application.
4.2 Orders of Action–Sound Separation

In an essay entitled *Mechanical Music*, Bartók (1976) establishes a continuum ranging from musical instruments that he regards as being more *human* towards more *mechanical* instruments, according to the number of foreign objects that interfere between the human body and the vibrating sound source, and the amount of time the human body has control of the vibration. Based on these criteria, he places various instruments in the following order: the voice, wind instruments, bowed string instruments, plucked string instruments, pianos, organs, barrel organs, player pianos, and finally the gramophone and the radio (Jordà 2005: 24). Written in 1937, the essay provides an insight into the mind of an influential 20th century composer, and his concerns about what he calls the “mechanization” of music. He is generally biased against contemporary “optimists” who seem to believe that “mechanized” instruments (such as the theremin) could some day become a substitute for “live music.” He expresses fears about mechanical music flooding the world to the detriment of live music, and concludes: “May God protect our offspring from this plague!” (Bartók 1976: 298)

Whether or not we have been spared from this abominable fate may be an interesting discussion. Much has changed since Bartók’s essay. Although the vantage point of this thesis shows that DMI developers face similar challenges as the creators of “mechanical instruments” seven decades ago, I do not share Bartók’s pessimism. The separation between action and sound in DMIs is of different order than in the analog electronic instruments described in *Mechanical Music*. Similarly, the separation between action and sound in pianos is of a different order than in more direct acoustic instruments, and so on. Historically, I think that new, unique ways of experiencing and thinking about music have developed for each new order of action–sound separation that has emerged. The action–sound separation is paralleled with a need to act and perceive on new and different levels, resulting in new musical paradigms that are relevant for existing and future generations. I have identified five different orders of separation: *incorporated, direct, mechanical, analog electronic* and *digital*. I hasten
to add, however, that the acoustic (pre-electric) orders should be seen as a continuum and not discrete categories.

**Incorporated:** The performer is the sound

While the voice is clearly the most versatile example in this category, whistling, snapping, clapping and various other percussive body sounds can be considered to be incorporated instruments. The earliest forms of music probably originated from body sounds, and may have been important for displaying commitment, strengthening social relations, communicating affect and producing different feelings of affect in others (Mithen 2005).

**Direct:** The performer is in direct contact with the sounding unit(s)

Most acoustic instruments could be classified as being direct, although to varying degrees. The Jew’s harp borders against the incorporated category, because most of the sound is actually caused by the teeth and skull vibrating and resonating in the mouth and nasal cavities. Sound from wind instruments is also a combination of corporeal and instrument vibrations, but here the resonator is in the instrument. Toward the other end of the continuum within this category we have stringed instruments plucked with picks and percussion using sticks and mallets. Musical instruments that were separate from the body may have been what enabled the study of music as a science, exemplified by Pythagoras’ musical theories and experiments with musical sound in ancient Greece. Additionally, the diversity of musical styles and practices around the world may be due to the materials used to make instruments—different timbres in combination with the human voice may have made some intervals sound better than others, thus creating characteristic musical scales dependent on a culture’s natural environment (Sethares 1998).

**Mechanical:** The performer initiate mechanical processes that result in the production and (in some cases) modification of sound

Keyboard instruments, such as the organ, harpsichord and piano, and other instruments that have mechanical links, belong to this category. On this order of separation, action and sound can clearly be identified as different processes.
The increased range of control afforded by mechanical processes made it easier for one person to play polyphonic melody structures over several octaves, and may have elevated the role of the composer as an autonomous creator of music. The level of abstraction and conceptualization in composed works increased dramatically between the 16th and 20th centuries, and I think this development would have been impossible if many composers had not had the experience of developing and trying out themes and ideas on organs, harpsichords or pianos.

**Analog electronic:** The performer triggers electric impulses that are relayed to a sound generator

Early analog electronic instruments included the theremin, Ondes Martenot, Trautonium, and Hammond organs. Later, analog synthesizers became popular starting in the 1950s. Electronic instruments introduced sounds never heard in music before, and have greatly influenced the development of music culture in past decades.

**Digital:** The performer triggers streams of digital data which are coded into digital representations of sound and converted to physical sound

Already described at length in Chapter 2, this category features instruments with the highest order of action—sound separation to date. Digital music has existed for several decades, but the possibility of processing complex synthesis techniques and musical structures in real-time is relatively new (computers were not fast enough until the last decade). In other words, natural constraints prevented the real-time performance of digital music in the first few decades of its development, and musical styles based on preprogrammed sequences of sound have had more time to develop. I would not go so far as calling this condition a cultural constraint, but I think it forms a cultural context in which it may be difficult to realize how DMIs for real-time performance should be developed, because there is already a large demand for DMIs based on sequencing and with fixed mapping presets.
These five categories based on orders of action–sound separation form the basis for the empirical study in Part II. The musicians that I have interviewed are all DMI performers with the additional experience of playing non-DMI instruments. I have made sure that each one of the four categories apart from digital—incorporated, direct, mechanical and analog electronic—are represented by at least one of the participants. This selection of participants was based on a hypothesis that experience from different instrument categories may cultivate different ways of thinking about music, and one goal of the study is to compare the answers with a view to test this hypothesis. In other words, these five categories are a method to understand which effect the increasing levels of action–sound separation has on our experience of music, and should not be considered an *organological* classification of instruments. Kvifte (1989) has put forward a more scientific approach to new ways of classifying instruments, including electronic and digital instruments, and it is not my intention to suggest an alternative classification system.

**An aside on electric instruments**

There is a special class of instruments that is not described in the above categories, namely *electric instruments* such as the electric guitar. I wish to add a few comments regarding this omission. First, I emphasize that the above categories represent orders of action–sound separation—they are about what happens in the instruments, and not a classification system of instruments per se. Second, electric instruments should not be seen as belonging to a unique order of action–sound separation, because they feature electronically amplified acoustic sounds. In the scheme of the categories presented in this section, I would say that an electric guitar is a direct instrument with varying degrees of electronic *effects*. Following the same logic, a singer singing through a microphone is an incorporated instrument with electronic effects. Electronic and digital effects should be considered additions to instruments and controllers. The importance of the electric guitar in the development of rock music shows that electronic effects in the amplification process have had a major impact on the music of the past several decades.

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11 The difference between instruments, controllers and effects is a controversial topic, but in the context of this thesis, I do not intend to delve into this discussion.
4.3 Toward New Roles in Music

With the advent of digital musical instruments, the relationship between performer and sound became an arbitrary one (Brown et al. 1996). Brown et al. (ibid. 28) recall how expectations that digital technology would liberate the composer from the constraints of acoustic instruments gradually matured into the realization that, paradoxically, composers became more involved with the design and implementation of instruments. A consequence of working with DMIs seems to be that instrument design, composition and musical performance are becoming fused into a process where the same person switches between two alternating modes. In “run-time-mode”, the musician is the composer/performer, and in “edit-mode” the musician is the instrument designer/composer (Jordà 2005: 20). These modes are essentially the same as the phenomenological modalities of ready-at-hand and present-at-hand, which are concepts that were introduced in Being and Time by the philosopher Martin Heidegger (1962). According to Heidegger, a tool is ready-at-hand when in use, and present-at-hand when the tool breaks and the user needs to fix it. Heidegger’s point is exemplified by a carpenter who uses a hammer for its purpose without consciously thinking about the hammer itself. However, when the head falls off the hammer, the tool becomes the focus of the carpenter’s attention and he sees the hammer in its true phenomenological light. A survey conducted by Magnusson and Mendieta (2007) exposed that many musicians with experience of both playing acoustic and digital instruments see the computer as a distracting tool that does not lend itself to deep concentration, because of the need to constantly switch between the two modes of being ready-at-hand and present-at-hand.

This blurring of traditionally separate roles in music is seen in many areas where DMIs are used. Freeman (2008) challenges the classical view of music as something that is created by a composer, to be interpreted by performers, and finally passively perceived by an audience. He argues that such a view, which he calls a “feed-forward network”, idealizes the composer as the sole source of music. In this classical view, the composer is seen as someone who receives “divine inspiration” and translates this into a score. Performers translate the score into sound, and the audience is supposed to sit passively and not disturb the “magic of the moment.”
Figure 4.2. Feed-forward network. The composer and performer are seen as active in the creation of music, while the audience assumes a passive role with no influence on the music (Freeman 2008).

Freeman suggests that technology can provide ways to empower the audience’s influence on the music-making process, turning it into a “feedback loop”. In this context, the “composer” is the designer of the instrument, and music is created by performers and/or an audience who interact with the environment set up by the designer. Such environments can be realized in a number of different ways: Cameras may set up to detect motion in the audience, individual controllers may be handed out, etc.

Figure 4.3. Feedback loop (Freeman 2008).

I believe that giving the audience a degree of influence on the musical result could be one way of de-mystifying DMIs. It increases interaction between performers and the audience, and between individuals in the audience. Cleverly designed interactive musical environments could prove to be both aesthetically rewarding and educational, because it introduces the audience to DMIs in a hands-on fashion, providing the
ability to understand what is happening in the program. As I have mentioned earlier, I think such an understanding is a key to fully appreciating the real-time performance of DMIs.

In the same way as the advent of digital musical instruments is blurring the divisions between the traditional roles of composer, performer and audience, it has also introduced a new continuum between sound engineer and live musician. Certain groups of performers, for example DJs, can be said to belong to both categories. Depending on their performance style, some DJs are more towards the live musician end of the scale than others. Club DJs have taken the art of interweaving tracks, rhythms and effects to a level that borders on composition, creating layers, textures and musical forms that can be accredited the DJ as much as the musicians behind the recorded material on the various source tracks. The playback and spatialization of electroacoustic compositions—referred to as diffusion—is also often considered a live performance due to the intricate details that need to be considered in the process of adjusting the sound according to a diffusion score (Pasoulas 2008). Contrasted with the more traditional view of a sound engineer as someone who modifies the sound of music performed by musicians, the processing of sound in electroacoustic performances is considered an integral aspect of the music making process. According to my definition in Chapter 1, real-time performers of DMIs are placed on the far “live musician” end of the sound engineer–live musician continuum.

4.4 Conclusion

In this chapter, I have focused on the cultural significance of new technology, and presented a view of cultural development as “resonating” in an interplay between natural and cultural forces of influence. Discovering new affordances created by technological advances is an orientation process which may take years or decades, and may challenge existing paradigms in music. DMIs are seemingly beginning to challenge traditional concepts in music. I have also presented five categories of instruments based on order of separation: incorporated, direct, mechanical, analog electronic and digital. These five categories form the basis of the empirical study in Part II.