Music

The history of Western music involves a transition from music understood as reflecting the harmony of the cosmos to the industrial production of desegregated sounds. From classical antiquity until the sixteenth century, music was a way to cultivate the senses for the good of a specific ethos. Politicians and physicians still talked about music when they searched for the right mixture of powers in politics or the right mixture of bodily humors in medicine. But with the demise of cosmological harmony manifested in Pythagorean proportionality, music became the disembedded art of sound production. Since the nineteenth century, modern music has been influenced substantially by scientific progress and its technological fallout. The technogenic production of sound reflects the disappearance of the traditional deep ethical relevance of music, which is now at most of positivist psychological relevance to human life.

Music and Ethics

In Greece as in other cultures, music and dance were significant threads in the fabric of every day life. Hymns were sung to praise and address the gods of its ethos. Outside religious rituals, music accompanied wedding, funerals, harvests and wars: most social occasions not only had their own time but also were marked by their own musical instruments and modes. From ancient times to the sixteenth century, philosophers, musicians, physicians, and politicians understood music as an art intimately associated with ethics. Authors such as Plato (*The Republic*), Aristotle (*Politics*), Boethius (*De musica*), and Isidore of Seville (*Etymologiae* [Etymologies]) considered the influence of specific modes of music, rhythms, and musical instruments on body and soul (Anderson 1966; West 1992). It was believed that music not only mirrored the cosmos but also influenced the constitution of both individuals and society (Lippman 1992). Plato in *The Republic* describes different modes and rhythms with regard to their ethical effects (books 2, 3, and 7) and stresses their importance for education. Along with arithmetic, geometry, and astronomy, *musiké* was used as a sensible route to the appreciation of appropriate correspondences: “musical training is a more potent instrument than any other, because rhythm and harmony find their way into the inward places of the soul. . . . he who has received this true education of the inner being will most shrewdly perceive omissions or faults in art and nature”

(Book III, ¶401).

The demonstration of the harmonic order of the cosmos with the help of a monochord, a rectangular sound box with a single stretched string, was the cornerstone of Greek ethical education. Teacher introduced pupils to the proportions of the musical consonances. According to one legend, it was Pythagoras of Samos who discovered the connection between the first four numbers and the musical consonances (octave 2:1, fifth 3:2, and fourth 4:3) and thus became the founder of music. For Pythagoras and his successors, musical consonances mirrored the harmonic order of the world. The first four numbers, the so-called *tetraktys*, were considered harmonic because they symbolized the four seasons, the four directions, and the four humors. This doctrine was handed down to the Middle Ages through Boethius's *De musica*, which distinguishes between *musica instrumentalis* (music that can be heard), *musica mundana* (music of the heavens), and *musica humana* (harmonic mixture of the bodily humors).

The Disembedding of Music

In the sixteenth and seventeenth centuries, the notion of music as the reflection of a given harmony started to fall apart. Doubts about the authority of the Pythagorean legend and new technologies such as musical printing questioned the millennia-old assumption of the embeddedness of music in a cosmological order and its ethical relevance. In a diverse range of treatises such as Gioseffo Zarlino's *Le istitutioni harmoniche* (1558; The harmonic foundations) and Johannes Kepler's *Harmonices mundi* (1619; The harmony of the world) *musica instrumentalis* is still considered an echo of the music of the spheres and the body. But at the same time, authors appear who complain that music has lost its power to form an ethos: Antonio de Ferraiis' s *De educatione* (1505) and Richard Pace's *De fructu qui ex doctrina percipitur* (1517; The benefit of a liberal education), for example, on the education of princes, follow the tradition of Plato and Aristotle by emphasizing the ethical value of a musical education. But they lament the loss of the sense for harmony, a sense that, from the pre-Socratics to their contemporaries, was fundamental to recognition of the good.

For music that was played in the Middle Ages, the technique of musical notation was understood as a memory aid for its performance. This changed during the sixteenth century when the German composer Nikolaus Listenius claimed that a composition should be an *opus perfectum et absolutum*, an independent piece of art. He rejected the traditional notion of composition as the expression of God's creation (Kaden 1992). Notation did not serve as a blueprint for musical performance, but for the production of an autonomous, timeless piece of art made of composed tones. The Swiss scholar Henricus Glareanus (1488-1563) explicitly declared notated musical tones the foundation of music. The technological invention of musical printing in the late fifteenth century fostered this new understanding of composition as the production of a piece of art and made possible its conservation and reproduction. The musical artifact, namely, musical tones aesthetically arranged according to the tastes of the time, became the quintessence of music. Music now was understood as an art that fosters the individuality of its creators.

At the same time, philosophers and mathematicians, such as Giovanni Benedetti, Galileo Galilei, Marin Mersenne, and Isaac Beeckman, made the musical tone and its acoustic foundations an object of empirical research. These figures were the first to examine the validity of the canonical tradition of Pythagoras, rather than seeking to demonstrate its truth. Their experiments refuted the doctrine that the *tetraktys* was the harmonic foundation of music. In his *Discorsi e Dimonstrationi Matematiche, Intorno a Due Nueve Scienze* (1638; Dialogues Concerning Two New Sciences), Galileo proved that the traditional assumption that the same ratios produce musical consonances when they "expressed relative weights of hammers, weights attached to strings, or the volume enclosed in bells or glasses" was wrong (Palisca 1961, pp. 128-129). What before had been considered a universal law reflecting a universal harmony was suddenly demystified as an empirical fact true only "for strings with the same thickness, length, and quality, and stretched to the same tension" (pp. 128-129). In his *Harmonie universelle* (1636; Universal harmony), Mersenne developed a mathematical formula for calculating the relation between the frequency of oscillation and the pitch of a string. By replacing the length of a string segment (e.g., 2:1 for the octave) with the frequency of oscillation (1:2), he anticipated the shift from cosmology to science (Cohen 1984).

Music as an Object of Scientific Research

The invention of measuring devices in the eighteenth century transformed musical qualities to calculable quantities. The tuning fork, developed by the trumpeter and lutenist John Shore in 1711 and Étienne Loulie's *chronomètre* (1696) gave a technological impetus to the quantification of pitch and tempo. Loulie's apparatus was almost 2 meters high, and although considerably improved by the French mathematician Joseph Sauveur at the beginning of the eighteenth century, was used only by music theorists and scientists. But in 1816 Johann Nepomuk Maelzel began manufacturing his version of the metronome (invented circa 1812 by Dietrik Nikolaus Winkel). With Maelzel's successful commercialization of the metronome, which was soon adopted by main composers, timekeeping became common in musical practice. The Italian tempo indication (for example, adagio, allegro, or presto), common since the seventeenth century, had determined the characteristics of a piece. The metronome fixed those characteristics to defined units per minute, replacing the description of qualities with quantifiable measurements of speed.

At the beginning of the eighteenth century, Sauveur founded the science of acoustics, a discipline designed to explore sound the same way optics analyzed light. Unlike his predecessors Mersenne, Kepler, or Galileo, who still searched for the harmonic principles of music, Sauveur did not distinguish between music and noise; he treated both as kinds of physical sound. This new scientific perspective on music created the foundations for musical acoustics, which, within one and a half centuries, would transform musical theory. In his *Génération harmonique* (1737; Harmonic generation), the French composer Jean-Philippe Rameau became the first to use Sauveur's research to support his own musical theory by referring to its acoustical foundations (Palisca 1961). Jean-Jacques Rousseau (1712-1778), the French philosopher, introduces 'acoustics' into the terminology of music with his *Dictionary of Music*. Whereas instrument makers used discoveries in the field of acoustics to improve musical instruments such as the piano and the violin, musicians, composers and musical scholars mostly neglected the importance of acoustics for their own work.

During the nineteenth century, music became the object of systematic scientific research in the laboratories of physicists and physiologists. In order to exchange and compare results within the scientific community, they had to develop standardized parameters. The acoustical examination of the tone required a universal point of reference. In 1834, following a suggestion of the German acoustician Johann Heinrich Scheibler, a convention of physicists in Stuttgart adopted Scheibler's standard pitch of a'= 440 hertz. Fifty years later an international committee agreed on a standard pitch with global validity. A professionally defined and bureaucratically prescribed standard did away with the diversity of pitches that had been characteristic of each place and its ethos. The millennia-old art of attuning oneself to the appropriate and good of a certain place was replaced by submitting to experts' guidelines.

The German physiologist Hermann von Helmholtz (1821-1894) was the towering figure in acoustical research on music in the second half of the nineteenth century. In his study *On the Sensations of Tone* (1863), he reformulated the Pythagorean interpretation as a scientific problem and presented his new physiological, psychological, and physical foundations of musical theory. Helmholtz was an advocate of "objectivity," a new scientific paradigm of his time that was based on the use of scientific instruments. By developing scientific instruments that made not only the analysis but also the technical synthesis of sounds of different musical instruments possible, he revolutionized the understanding of music. Since Helmholtz, the axioms and technological fallout of the acoustical laboratory frame the understanding and meaning of musical instruments, hearing, consonance, and tone.

Music as the Production of Sound

At the beginning of the twentieth century, Helmholtz's laboratory notion of music as sound production became an everyday assumption. Without his acoustical research, the inventions of the phonograph by Thomas Edison in 1877 and the telephone by Alexander Graham Bell in 1875 would have been unthinkable (Peters 2004). The phonograph was commercially exploited by organizing concerts where real musicians had to compete with the machine. The audience was supposed to recognize that the machine was able to mimic musicians (Thompson 1995). In the early telephone days - the late nineteenth and early twentieth centuries - the new technology of analyzing and synthesizing sounds was primarily used to transmit concerts, operas, and variety shows to marketplaces, bars, hotels, or the parlor. Radio, which debuted in 1920 replaced the telephone as a device for broadcasting music.

At the same time new technologies made music an industrial product, the sound of industrial machines such as airplanes and trains entered theaters and concert halls. Arthur Honegger's *Pacific 231* (1923), a musical dedication to the then strongest American locomotive, Kurt Weill's *Der Lindberghflug* (1929; The Lindbergh flight), or Frederick Converse's *Flivver Ten Million* (1926), praising the 10 millionth Ford car, document how music reflected the industrial age and its technological innovations (Braun 2002). The Italian futurists even used the noise of steam engines and other machines together with conventional musical instruments in order to create industrial soundscapes. Electronic instruments gave birth to innumerable new sounds. THE AETHEROPHONE (1921) BY Leon Theremin, the Sphärophon (1926) of Jörg

Mager, and Maurice Martenot's Ondes Martenot (1928) produced artificial sounds that were enthusiastically welcomed by concert and movie audiences. Machines for synthesizing sounds were introduced since 1929 and became commercially viable with the synthesizer invented by Robert Moog in 1964.

The invention of the triode vacuum tube by the American inventor Lee de Forest in 1906 and of the transistor in 1947 opened up the possibility of amplifying and modifying sounds. It was the avant-garde of popular music who, in the 1950s and 1960s, were fascinated by the new technological potential and started to use amplifiers, microphones, and loudspeakers. With the help of electrified musical instruments such as the electric guitar, music groups invented and produced their own characteristic sounds, that is, their individual "trademark sound," which facilitated commercialization in popular as well as in classical music. Since then, sound engineers behind the scene have become the ones who produce the sounds adapted to the taste of different consumer groups. Technicians operating recording machines, filters, and mixers determine the musical output on records and in concert halls. Musicians and composers used machines like the tape recorder, the vocoder, the synthesizer, or the sampler to design new sounds or to imitate the sound of musical instruments. Computer Programming, tape recording, the 'playing' of turntables or musical instruments were equally used as means for sound production.

The technological imperative of contemporary music was discussed controversially among composers, philosophers, and musicologists after World War II. In "Music and Technique" (1959), Theodor W. Adorno expressed disapproval of contemporary composers who incorporated technology into their works. He called their search for a new kind of music based on the electronic generation of sound a banality that would raise engineers to composers and lower composers to technicians. According to him, music without notation and interpretation would be nothing but a technogenic production and reproduction of something audible. In contrast to Adorno, apologists of electronic music such as Karlheinz Stockhausen (1928-), John Cage (1912-1992), and Pierre Schaeffer (1910-1995) praised its new forms of expression that overcame the outdated limits of traditional music. They sought a new kind of music that would provide the technological society with its appropriate musical expression.

In the 1980s the computer ushered in the era of boundless possibilities of sound production. Today new sounds are generated, conventional ones are simulated, and all types of sounds are mixed arbitrarily regardless of their historical and cultural meanings (Théberge 1997). With little fanfare, sound designers and artists use noises and artificial sounds as well as plainchants venerating the Madonna or pop songs by the American singer Madonna as a resource for their artistic productions. Be it songs of African shamans in the supermarket or classical symphonies in a parking lot - disembedded sounds have become the background music of a technogenic society.

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