WORKING IN CONCERT: A CULTURAL HISTORY OF SCIENCE AND MUSIC FROM THE 18TH TO THE 20TH CENTURY

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While at Wiko I was able to conduct research on two different topics. The first was gene patenting and race and genomics. I worked with molecular biologists at the Charité in Berlin on how German molecular biologists do not (and indeed may not) use "racial" or "ethnic" markers, but rather other genetic markers linked to various diseases. This work

will proffer an interesting contrast: while biomedical researchers in both the US and Germany are strongly committed to the future of personalized medicine, critical differences in approaches, based on history, are very informative. I also researched the history of gene patenting in Europe with colleagues at the European Patent Office in Munich. Such a study illustrates that different patent regimes reflect the political and economic interests of various countries: the US patent system is neither "natural" nor inevitable.

My second project is a book-length study of how physicists, physiologists, (later) engineers, and musicians collaborated to generate new forms of musical aesthetics from the 19th century to the 1960s. It is an elaboration of my earlier work, *Harmonious Triads* (MIT Press, 2006), and I spent the majority of my time at Wiko fleshing out this project. I link the acoustical research of the 1830s and '40s to Theobald Böhm's famous improvements on flute design and the scientist Charles Wheatstone's invention of the concertina. I then tackle Hermann von Helmholtz's contribution to the physics of acoustics, the physiology of hearing, and the improvement of musical instrument manufacture, particularly Steinway pianos, for which he served as a technical advisor. The doyen of physics held strong views about the superiority of just temperament over equal temperament for keyboard instruments. He experimented on musical instruments as if they were scientific ones. Both the piano and the harmonium helped him to study issues of beats, upper partials, consonance, dissonance, and various tuning temperaments.

I am also interested in how late 19th- and early 20th-century physiological works influenced numerous musical pedagogues teaching the requisite skills of pianists and bowed-instrument players. Of particular interest is the role that the so-called universal principles of mechanics in the natural sciences played when musicians wished to communicate their knowledge to their pupils. The story that unfolds touches on an interesting historical theme, namely how other forms of contemporary culture, in this instance, music, perceived the roles of physics, anatomy, and physiology in pedagogy. Some musicians, rather controversially, saw natural scientists as possible allies in pedagogical matters. A number of 20th-century physicists and musicians argued that musical treatises based on scientific research enabled students to enhance their own styles of playing. In this case, by drawing upon the universal principles of natural science, the individual could cultivate her or his own technique.

The move during the last two centuries of a number of musical pedagogues to draw upon the mechanical principles of the natural sciences in order to improve playing technique and the teaching thereof also sheds light on the interactions between experimental natural philosophers (and later natural scientists) and musicians. On the one hand, these

principles were seen as a way to standardize the techniques characteristic of certain conservatoires. Inevitably, it was in part about training and disciplining groups of musicians. Numerous composers felt that musicians should be as rigid and disciplined as machines, expressing their consternation over liberties taken with their compositions. The mechanism of the piano had progressed so far by the early 20th century that the music teacher and composer Adolf Ruthardt triumphantly proclaimed, "Our age enjoys the advantage of being able to look back on a definitively concluded evolution in piano playing, or let's say, in the virtuosity of the instrument; for no proof is needed any longer than the mechanics and technique of this branch of the art and have not achieved their respective culminations." For Ruthardt at least, "virtuoso" now referred to the instrument, not its player. One is reminded here of Karl Marx's discussion of the relationship between the worker and the machine: "It is the machine which possesses skill and strength in place of the worker, is itself the virtuoso, with a soul of its own in the mechanical laws acting through it; and it consumes coal, oil, etc. (*matières instrumentals*), just as the worker consumes food, to keep up its perpetual motion." On the other hand, however, some also argued that these same principles of physics, anatomy, and physiology also augmented the performer's artistic potential. Many physicians and musicians alike felt that, with the assistance of science, performers could develop and sharpen more efficiently their own individualistic technique. They stressed the individuality of the performer, as only a human could provide nuanced timbre on a piano: in this respect, player pianos, the quintessence of mechanism, were a failure and deemed "soulless". Technology did not thwart individual interpretation, but rather increased it for those skilled enough to use it.

I also examine the influence of radio in Germany during the 1920s and '30s on the production of electronic musical instruments such as the trautonium. The objects and practices associated with the origins of radio, telegraphy, and telephony throughout Europe and the United States were the very same ones that created a new musical aesthetic and challenged musicians and composers to redress the use of the "mechanical reproduction" of music. Many composers, such as Edgard Varèse and Carlos Chávez, saw the new technologies of electrical and radio engineering as liberators of music from the tyranny imposed upon it by the Classical and Romantic composers. A new, creative aesthetic was now possible. Yet there were those who feared the loss of the human: musicians were being reduced to automata. Indeed, in some instances, they were being replaced. The ensuing debates were taken up within a larger framework of the role of technology in general in society during the late 19th and early 20th century.

The 1920s were a fascinating decade for Berliners. In the immediate aftermath of World War I, it seemed unfathomable that the city would soon become the world's third-largest municipality. Despite the immediate political and economic turmoil, there was cause for optimism. The Bauhaus centered in nearby Dessau was establishing itself as the leading German school of architecture and design. German cinema was flourishing, featuring what would become classics, such as "Dr. Mabuse, der Spieler" (Dr. Mabuse the Gambler) and "Metropolis", both directed by Fritz Lang. Berthold Brecht and Kurt Weill were entertaining the theater-going throngs with rather poignant political morals, while similar messages from the pen of journalist and cultural critic Walter Benjamin could be read in the city's newspapers. The capital could boast that it was the home of some of the world's leading scientists, including the likes of Albert Einstein, Max Planck, Max von Laue, Gustav Hertz, Otto Heinrich Warburg, and Fritz Haber. And German radio was beginning to fill the airwaves with news and music. With this period of renewed industralization and cultural, technological, and scientific achievements, a group of applied physicists, physiologists, engineers, and musicians were tinkering away, inventing new musical instruments and genres. The technical expertise of radio engineers, combined with the musical expertise present in the Berlin Hochschule für Musik and the financial backing of German companies and the Prussian Ministry of Science, Art, and Popular Education, enabled the production of a new electric musical instrument, the trautonium, which could be used for microtonal pieces and could mimic the timbre of numerous more traditional instruments.

Radio and the research of applied, technical physicists, however, are not the only contexts in which we need to situate electric music in Germany during the late 1920s and '30s. Also critical was the research by physiologists on analyzing and synthesizing human sounds, particularly vowels and their corresponding formants, by using gramophones. It was also a period of a new aesthetic, *Neue Sachlichkeit*, and of composers such as Paul Hindemith, Igor Stravinsky, and Arnold Schönberg, who were trying to push the envelope of what constituted music and in essence saw themselves as following Ferruccio Busoni's calling in 1907 to create a new form of music based on atonality, among other things. Such an aesthetic wished to distance itself from one of (for lack of a better phrase) the mechanical reproduction of music.

In the aftermath of World War II, a new musical aesthetic arose out of the ashes. It was one that, similar to the music of the inter-war period, required the cooperation of musicians, scientists, and engineers. Once again, radio played a critical role in the development of this new musical genre, whose foundations were being laid between 1948 and

1953. It was a musical genre based on electronic circuitry, amplifiers, and loudspeakers. Much of it relied upon storage devices such as film soundtracks, phonographs, tape recordings, and later computers. Generally, there were three distinct groups belonging to the genre of electronic music. *Musique concrète*, which originated in Paris in 1948, was initially based on recording natural sounds via microphones onto discs and tapes and then manipulating and transforming these sounds using various apparatus. Pierre Schaeffer and Pierre Henry were the principle protagonists. Cologne's "elektronische Musik", located at the studio of Norddeutscher Rundfunk (Northern Germany Radio), later Westdeutscher Rundfunk (West German Radio), featured the collaboration started in 1951 between the physicist Werner Meyer-Eppler, the sound engineer Robert Beyer, and the composers Herbert Eimert and later Karlheinz Stockhausen. While they too manipulated stored sounds, they stressed the production of sound by various objects, including the melochord, the monochord, and most importantly generators/oscillators. The sounds were organized following the serialism of Arnold Schönberg and Anton Webern. Finally, the music for magnetic tape of John Cage and Bebe and Louis Barrons and the tape music of Otto Luening and Vladimir Ussachevsky dominated the New York music heard in the early 1950s. These two New York traditions, which were by and large independent, drew upon natural and electronic sounds recorded onto tape. The principles organizing the sound, however, varied with their aesthetic views.

While at Wiko I was able to work in numerous relevant archives in Berlin, Munich, and Cologne. I collaborated with colleagues at the Max Planck Institute for the History of Science in Berlin, where I offered three papers. I also gave two lectures in Jena (one at the University and one at the Max Planck Institute for the Science of Human History) and one at the University of Vienna. Finally, I offered an after-dinner speech to a gathering of the Alexander von Humboldt Foundation in Washington, D.C.

As everyone correctly states, the staff here is truly phenomenal. The librarians will find things for you that you did not know existed! The Fellows are treated incredibly well: unlike at the American Academy, we are actually considered important to the institution. My only recommendation: I strongly encourage future Fellows to seriously consider living outside of Wiko. Living in Grunewald seems to me like living on Staten Island. And, given the renovation of Villa Jaffé and the neighboring villa, which has the approximate surface area of the state of Baden-Württemberg, sleeping and working were often difficult, although I do thank the staff for accommodating me by offering other rooms. It does not look as if the renovations will end any time soon.