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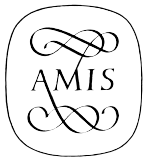

Seeing Instruments

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Let us begin with an observation about Western Art music that might seem heretical to the organologist: instruments, even as they are omnipresent and utterly essential to musical practice, are not always visible within or central to the broader discourses of music. Indeed, across history, various people have assumed—or argued for—a separation between music and the technologies that make it possible. This takes various forms: one of the central themes of Honoré de Balzac's short story "Gambara" (1837) is the thorny relationship between music's ideality and materiality (the title character is both a composer and instrument designer, with training in acoustics). Wagner hid the orchestra beneath the stage in the Bayreuth Festspielhaus, arguing that it should be as "carefully concealed from him as the cords, ropes, laths, and scaffoldings of the stage decorations." Pierre Schaeffer believed an entire new kind of musical object would be produced by magnetic tape, which liberated sound from its source.[55] Sometimes this separation reflects a resistance to what we could call musico-technological determinism: amid the clamoring for new instruments in the early twentieth century, for example, some critics dismissed their contemporaries' concerns that a lack of new technology hindered the musical imagination.[56] And of course familiarity produces its own invisibility: plenty of thoughtful analyses of Mozart's string quartets and Beethoven symphonies utterly ignore the particulars of the instruments called for in the scores. Sonata theory hasn't been shaped by organological insight.

At stake here is the complex relationship among the discourses of music—ideas, philosophies, theories—and the practices and materials

55. Richard Wagner, "Preface to the Public Issue of the Poem of the Bühnenfestspiel 'Der Ring des Niebelungen' (April 1863)," in *Prose Works*, trans. A. Ellis, 3 (London: Paul, Trench, Trübner & Co., 1899): 276–77; on the concept of the sound object, see Pierre Schaeffer, *In Search of a Concrete Music*; on acousmatic listening, see Brian Kane, *Sound Unseen: Acousmatic Sound in Theory and Practice*.

56. For a discussion of the criticisms of the hopes placed on electronic instruments in the early 20th century, see Thomas Patteson, *Instruments for New Music: Sound, Technology, and Modernism*, in particular the discussion of Hans Pfitzner's suspicions surrounding new music, 14–17.

of music.[57] Understanding this relationship means exploring, in historical terms, the very *concept* of an instrument: whether particular instruments are understood to be visible or invisible, how they are understood to function, and to what ends. Importantly, how an instrument actually functioned can differ quite radically from how it was *perceived* to function.

One way to tackle this set of questions is to turn to a discipline that has long grappled with complicated relations between ideas and things, and the connections between the practices and the production of knowledge: the history of science.

The Importance of Practice

History of science hasn't always attended to such questions; indeed, until the 1970s, the history of science usually implied the history of scientific *ideas*, without necessarily attending to practices that led to the production of those ideas. Steven Shapin and Simon Schaffer put this nicely: the history of science used to prefer "idealizations and simplifications to messy contingencies, speech of essences to the identification of conventions, references to unproblematic facts of nature and transcendent criteria of scientific method to the historical work done by real scientific actors."[58] While this essay cannot rehearse the entire history of the discipline, it is worth noting a few key moments before alighting on a handful of concepts that can speak to organological concerns.

A seminal figure in this history is Thomas Kuhn and his concept of the scientific paradigm.[59] Famously, Kuhn challenged the idea that scientific theories underwent a continual process of revision and refinement that moved ever closer to the truth; rather, he argued, the history of science was marked by periods of relative normalcy interspersed with by radical shifts that rendered entire structures of knowledge obsolete. Although it was those radical shifts that received the lion's share of attention, it was his characterization of normal science that turns out to be most important here. A paradigm, for Kuhn, was not simply a theory of the world, but rather an ensemble of ideas, practices, scientific instru-

57. I explored some of these questions in *The Orchestral Revolution: Haydn and the Technologies of Timbre*, in which I was interested in understanding the central role played by the orchestra and orchestration in the radical re-evaluation of the power of instrumental sound during the late Enlightenment.

58. Steven Shapin and Simon Schaffer. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, p. 16–17.

59. T. S. Kuhn, *The Structure of Scientific Revolutions.*

ments (and ways of seeing with them), problems, solutions, and outstanding questions. In the wake of Kuhn's work, a whole generation of scholars began to explore the practices that held together scientific communities.

One of the central institutions in this history is the University of Edinburgh, where, starting in the 1970s, a group of scholars, led by the sociologist Barry Barnes and the philosopher David Bloor, developed what is now known as the strong programme in the Sociology of Scientific Knowledge (SSK). As the name suggests, SSK seeks social explanations for the formation of all scientific knowledge. When Steven Shapin joined the unit in 1972 after completing his PhD in History of Science at the University of Pennsylvania, he became interested in combining this perspective with writing history. Around this time, he met and began to collaborate with the historian of science Simon Schaffer, which led to one of the key texts in the field: *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (1985). This book brought the perspective of the Edinburgh school to explain the radical difference between Thomas Hobbes's and Robert Boyle's approaches to the production of knowledge. While earlier scholars tended to dismiss Hobbes on the experimental method because it was assumed Boyle was correct about how nature worked, they treated the two figures symmetrically, looking to the sociology of experiment to understand how the conflict played out.

At the same time, scholars interested in scientific practice also began to draw upon anthropological methods, most notably Bruno Latour, who published *Laboratory Life: the Social Construction of Scientific Facts* in 1979, using ethnographic methods to study the laboratories in the Salk Institute for Biological Studies. As Eliot Bates discusses in his essay, Latour's later work that gave rise to Actor-Network Theory (ANT) has lately had a profound influence on music studies. It is worth adding a caution here: Latour's interest in the agency and autonomy of non-humans arose, in part, as a counterbalance to the emphasis placed on the constitutive powers of the social sphere emphasized by scholarship in SSK. Latour's *We Have Never Been Modern* (1993) is, in part, a direct response to *Leviathan and the Air-Pump*.[60] When scholars take Latour's ideas out of

60. Latour was, for example, concerned by the ways in which an emphasis on the sociological nature of facts can be used to undermine work on global warming. See Latour, "When Things Strike Back: A Possible Contribution of 'science Studies' to the Social Sciences."

the specific context of navigating the co-construction of nature and society, we risk losing the importance of the sociological that he sought to balance with the agency of nature and things.[61]

Construction and Use of Scientific Instruments

One reason these scholarly strands hold so much potential for scholars of musical culture is that the turn to understanding scientific practice also necessitated paying closer attention to the scientific instruments used by scientists. Crucial to Shapin and Schaffer's story was that Hobbes and Boyle disagreed about what role the construction and use of an artificial instrument could play in philosophical argument. Understanding scientific instruments became crucial to thinking about the history of knowledge more generally. In the 1970s, Albert van Helden began to publish on the telescope and its invention; Jim Bennett, who directed the Museum of the History of Science at Oxford, carried out extensive work on navigational and mathematical instruments.[62] The 1990s saw extensive publications in this area, which had become, in Bennett's words, a "vogue" by the early 2000s.[63]

Much of this scholarship has sought to make instruments visible again, by showing the kinds of work they do. Hans-Jörg Rheinberger, whose research focuses on the epistemology of experimentation, has written extensively on the role of instruments in science. In place of a notion of instruments functioning as transparent mediators between man and nature, he argues for understanding the multitude of "generally opaque intersections between the possible objects of inquiry and the instruments that become involved in the investigation."[64]

61. To paraphrase what I have written elsewhere, in many ways music scholars are the last people who need to be reminded that *things* have agency. Musical works and instruments have long been understood to wield special powers. See Dolan, "Musicology in the Garden," pp. 90–91.

62. See, for example, Albert van Helden, *the Invention of the Telescope*; Jim Bennett, "Presidential Address: Knowing and Doing in the Seventeenth Century: What were Instruments For?"

63. The scholarship here is too extensive to list, but for anyone seeking to delve into this rich literature, Lisa Taub's introduction ("Reengaging with Instruments") to the focus section "The History of Scientific Instruments" in *Isis* (2011) provides a cogent and concise overview and departure point.

64. Hans-Jörg Rheinberger, "Intersections: Some Thoughts on Instruments and Objects in the Experimental Context of the Life Sciences," p. 2.

Of particular interest is scholarship that not only illuminates the role played by scientific instruments in the production of knowledge, but that also focuses on the ways in which scientific instruments often disappear or become transparent in the scientific practices that they help inaugurate, precisely because of their success.[65] This is to think about how instruments function as mediators: to ask whether they are opaque or transparent and to explore their relationships—real or imagined—to other instruments and people.[66]

Science, Technology and Society

Questions of instrumental visibility and mediation make up only a fraction of the possible lines of inquiry someone interested in the history of musical instruments might explore by turning to the history of science and technology. A wide swath of this scholarship also speaks to questions that have been long driven organological inquiry, namely questions of instrumental invention and innovation. Much of this work abuts or is part of what is known as STS. A concise introduction to STS is impossible in this short essay, for it is less a coherent field and more a heterogeneous assemblage of a wide range of methodological approaches to the study of scientific and technological practices and the social construction of knowledge. Few scholars use STS as their primary disciplinary identification. Even the acronym STS can be interpreted in different ways: it stands for both "Science and Technology Studies" and "Science, Technology, and Society." The goals and scope of STS have been hotly debated, with particular tensions surrounding the relationship between STS and the history of science.[67]

Notably, musical instruments themselves are very much present in this body of scholarship. The STS scholar Karin Bijsterveld has worked on musical instruments and quite broadly engaged with sound, music, and audio technologies. With collaborator Martin Schulp, she approached

65. A beautiful example of this is M. Norton Wise's essay "Mediations: Enlightenment Balancing Acts, or the Technologies of Rationalism."

66. Historian of science John Tresch (University of Pennsylvania) and I explored ideas of mediation and the shared concerns of musicology and history of science in our 2013 article "Towards a New Organology: Instruments of Music and Science" (the title was a playful reference to Francis Bacon's *Novum Organum Scientarium*, 1620).

67. For a lively introduction to these tensions, see Lorraine Daston "Science Studies and the History of Science" and the response by Peter Dear and Sheila Jasanoff, "Dismantling Boundaries in Science and Technology Studies."

the question of perfection and innovation in Western classical instruments.[68] Their study makes a useful pairing with the organological work of Christian Ahrens, Jeremy Montagu, and Laurence Libin.[69] In a more recent essay, co-written with sociologist Peter Frank Peters, Bijsterveld has called for a theoretical approach to the idea of innovation in contemporary instrument building.[70] Scholarship on innovation in STS can offer both useful vocabularies and terminology for articulating historical problems, as well as productive methodologies for thinking about the relationship between technologies and the societies that develop and use them.

The Social Construction of Technology

The sociologist of technology Trevor Pinch (Cornell University) is a leading figure of SCOT—the social construction of technology—and has long engaged in projects that speak directly to musicological and organological concerns (though not exclusively: for example, he has carried out research on the rural automobile and the bicycle).[71] Scholarship in SCOT seeks to show the ways that different forms of technology are formed through complex social interactions; one of its marked features is that it seeks to avoid both technological and economic determinism. SCOT focuses first on what social groups do to technology, though it also attends to the ways in which technologies and social groups are co-constitutive of each other. He is well known as the co-author, with Frank Trocco, of *Analog Days*, a path-breaking study of the Moog synthesizer. Pinch and Trocco vividly document the complex interactions and contingencies that led to the establishment of the Moog synthesizer as a musical instrument. They explore how Moog's (reluctant) adaptation of the keyboard interface gave musicians (such as Wendy Carlos) a way into the synthesizer and its musical

68. Karin Bijsterveld and Marten Schulp, "Breaking into a World of Perfection: Innovation in Today's Classical Musical Instruments."

69. See Christian Ahrens, "Technological Innovations in Nineteenth-Century Instrument Making and Their Consequences"; Jeremy Montagu, "The Creation of New Instruments;" Laurence Libin, "Progress, Adaptation, and the Evolution of Musical Instruments."

70. Bijsterveld and Frank Peter Peters. "Composing Claims on Musical Instrument Developement: A Science and Technology Studies' Contribution."

71. It is worth noting that, depending on one's definitions, SCOT may or may not be understood as being part of STS.

potential.[72] Fellow inventor Don Buchla, by contrast, actively avoided the hegemony of the keyboard in favor of more experimental interfaces (such as drum pads); his instruments, though greatly admired by experts, have remained far less well known. This idea of "how past actions affect specific technological trajectories" is, in STS, called *path dependency.*[73] In his 2001 essay, "Why You Go to a Piano Store to buy a Synthesizer," Pinch explains this idea along with a bevy of related concepts and values. These include *interpretive flexibility,* which is used to describe the diverse ways different social groups might use a particular technology, and *closure,* which, in Pinch's words refers to "the specific closure mechanisms that . . . limit . . . interpretive flexibility."[74] Pinch goes on to trace the development of the Moog synthesizer using these concepts, providing a valuable model for how others might think about the histories of other instrumental forms.

Ears, Listening, and Audio Technologies

Much of this scholarship—even that not strictly focused on musical instruments—can offer suggestive paths of inquiry for the organologically inclined scholar. Media historian and sound studies scholar Jonathan Sterne has long drawn attention to the complicated relationships between our ears, practices of listening, and audio technologies. His *The Audible Past: Cultural Origins of Sound Reproductions* (2003) is a seminal, indeed field-defining, text in Sound Studies (along with, importantly, Emily Thompson's *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933*). Sterne's most recent book, *MP3: The Meaning of a Format* (2012), is a gripping account of the formation of this now-ubiquitous sound file format and is a treasure trove of approaches that anyone interested in the history of sound technologies might seize upon. To trace the history of the MP3 is to be reminded that the history of sound reproduction is most definitely *not* a history of steady progress towards something we could describe as ever more "realistic" or "faithful." Instead, Sterne draws our attention to questions of efficiencies. He writes, "The history of the MP3 belongs to

72. Trevor Pinch and Frank Trocco. *Analog Days. The Invention and Impact of the Moog Synthesizer.*

73. Pinch, "Why You Go to a Piano Store to Buy a Synthesizer: Path Dependence and the Social Construction of Technology," p. 382.

74. Pinch, p. 383.

a *general history of compression.* As people and institutions have developed new media and new forms of representation, they have also sought out ways to build additional efficiencies into channels and to economize communication in the service of facilitating greater mobility."[75] A focus on formats—as opposed to media more generally—is a call to greater specificity; it causes us, in Sterne's words, "to focus on the stuff beneath, beyond, and behind the boxes our media come in, whether we are talking about MP3 players, film projectors, television sets, parcels, mobile phones or computers."[76]

Particularly productive for scholars interested in musical instruments is Sterne's fifth chapter, "Of MPEG, Measurement, and Men," which traces the history of testing that shaped the MP3. To follow this history is to tap into a rich history of the production of particular forms of knowledge: as Sterne puts it, "stories of tests are epistemic stories."[77] The MP3 format was shaped by particular experts' ears and by particular recordings used in these tests (most famously Susan Vega's "Tom's Diner," but also recordings of Joseph Haydn, Ornette Coleman, and Tracy Chapman). These tests invite us to think more about the history of testing and evaluating musical instruments. One might, for example, examine the use of older repertoire by those seeking to establish new technologies as instruments. Clara Rockmore's performances of late nineteenth-century classics on the theremin—while terribly retrogressive for a composer like John Cage—helped to, we might say, calibrate the potential of the theremin as a truly musical instrument.[78]

The scholarship surveyed here holds the potential to complement existing organological methodologies, expanding the range of questions we can ask of instruments and the answers they can offer us. Of course, some of this scholarship leads musical instruments far away from the main concerns of organology. But this is a beautiful thing: musical instruments—precisely because of what Pinch would call their interpretive flexibility—are vital objects that perform diverse forms of work in many different disciplines. More than that, instruments can help bring disciplines, normally quite separate, into productive dialog.

75. Jonathan Sterne, *MP3: The Meaning of a Format*, p. 5.
76. Sterne, p. 11.
77. Sterne, p. 149.
78. In "The Future of Music," Cage complained, "When Theremin provided an instrument with genuinely new possibilities, thereminists did their utmost to make the instrument sound like some old instrument, giving it a sickeningly sweet vibrato, and performing upon it, with difficulty, masterpieces from the past," p. 26.