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OF EARS AND NORMS

THE PREVIOUS CHAPTER mapped a range of acoustic divergences in São Paulo since the 1910s. Looking at the use of the word *ruído* in the city's most popular newspapers, we identified six anti-noise waves, each involving specific sounds, groups, institutions, and regulations. This mapping showed that, particularly since the 1930 Revolution, noise as an urban problem tended to move back and forth between the specialists and the nonspecialists, behavioral and infrastructural issues. Wave after wave, a growing group of acoustics and public health specialists brought debates on noise control into a technical arena. Experts associated with the IBA (Brazilian Acoustics Institute), the IPT (Institute for Technological Research), and ProAcústica have tried to become the necessary points of passage for tackling urban noise by maneuvering the controversy away from the bitter politics of nonspecialists. It is now time to abandon the mapping approach and look at things closer to the ground. How precisely (and successfully) have these experts performed this maneuver? How have they managed to mediate between noise and noise control, problems and solutions?

This chapter focuses on several attempts to mobilize sound-politics via a range of techniques, devices, and national and international standards. To follow noise controversies in São Paulo we need to consider how experts have tried to stabilize two central actors: ears and norms. The most powerful argument for governmental intervention in noise problems has been evidence of its harmful effects

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on the human ear. By examining the ear and putting it through a series of tests, experts have generated an “average normal ear,” which I call *Ear 1.0*. To a large extent, the configuration of sound-politics depends on the strength of the links between noise, Ear 1.0, and public health initiatives.

There is, however, one link missing in this chain. The second actor is the black box responsible for emulating Ear 1.0 and conveying reliable, quantifiable, and transportable information. The sound pressure level meter (SLM), or *Ear 2.0*, is crucial here because it can convert Ear 1.0 into what Bruno Latour and Steve Woolgar call an “inscription device,” that is, an “item of apparatus or particular configuration of such items which can transform a material substance into a figure or diagram which is directly usable” (Latour and Woolgar 1986, 51). An inscription device requires someone (an expert) to *speak for* the device, translating and interpreting the information that shows up on the display screen. The SLM promises to bypass “subjective” and unreliable results by folding into its circuitry the thousands of ears amassed by Ear 1.0. As other authors have already traced the fascinating history of the stabilization of Ears 1.0 and 2.0 in the early twentieth century, the first section of this chapter will simply summarize some of these debates.

Building on the discussion about Ears 1.0 and 2.0, the second section focuses on the Brazilian Technical Standards Association (ABNT). In the 2010s, experts faced the daunting task of revising two technical standards for assessing environmental noise. As I show, drawing on participant observation, interviews, and minutes of meetings between 2011 and 2017, the endeavor was challenging because these revisions involved the input of groups with different interests and different understandings of what a technical standard should do. Despite the wish of many for a purely “technical” approach to noise measurement procedures, establishing the *norm* was permeated by political, administrative, and legal concerns. Drawing on Michel Callon, I argue that this heterogeneity of viewpoints made the ABNT meetings hybrid forums.

Ear 1.0 and Ear 2.0

It comes as no surprise that foundational sound studies texts focus so much on the 1870s–1930s period. Besides intensive industrialization, urbanization (often permeated by audible inter-ethnic tensions),[1] and mechanization, this is when we start to see a “paper trail left by sound-reproduction technologies” (Sterne 2003, 7). Gradually, with the global emergence of new technological entities for

[1] See Weiner (2014), Boutin (2015), and Bijsterveld (2008).

mastering sound, “the many different places that made up the modern soundscape began to sound alike” (Thompson 2002, 3). This is the period of consolidation for New Acoustics, a field centered on “new tools, new techniques, and a new language for describing sound” (Thompson 2002, 5).

The emergence of New Acoustics took shape thanks to the convergence of three groups. The first comes from medicine and includes mostly physiologists and otologists. The small size, internal specialization, fragility, and difficulty of access combine to make the human ear a remarkably difficult object to study. Békésy and Rosenblith (1948) summarize the gradual understanding of the ear in five foundational moments, each based on specific techniques and technology. In the first moment, up until the sixteenth century, specialists described the ear mostly based on observations of the external ear and eardrum. The second moment was the period of “gross anatomy,” represented by the work of Andreas Vesalius (1514–1564), Bartolomeo Eustachio (1510–1574), and Hieronymus Fabricius (1537–1619). By shattering the temporal bone of cadavers to examine the ear, these experts were able to probe into the middle ear ossicles, the auditory nerve, the cochlea, and the semicircular canals.

The third period, which started around the seventeenth century, focused on the inner ear, now accessible thanks to the miniscule chisels developed by Italian goldsmiths. Experts such as Thomas Willis (1621–1675) and Antonio Maria Valsalva (1666–1723) established a distinction between the outer ear, middle ear, and inner ear, and identified the cochlea as the actual locus of hearing. The fourth period was linked with the work of Antonio Scarpa (1747–1832). Based on microscopic observations of the cochlea, Scarpa “followed the course of the auditory nerve from the ear to the brain with a precision unknown before his time” (Békésy and Rosenblith 1948, 735–736). Finally, in the last period identified by the authors, experts increasingly began to rely on a variety of procedures, including dental burrs, comparative experiments with living animals, and recordings of electrical impulses. The corrosion technique of Joseph Hyrtl (1811–1894) allowed for the preservation of the cavities of the ear by filling them with wax. Marchese Alfonso Corti (1822–1875) identified the sections of the cochlea (one of which bears his name) and “the dimensions of the various parts of the [cochlear] membrane” (Békésy and Rosenblith 1948, 736). Hermann Helmholtz postulated that “individual nerve fibers acted as vibrating strings, each resonating at a different frequency” (Rossing 2007, 13).[2]

The unearthing of the human ear was paralleled by an interest in the boundaries of human hearing in regard to amplitude and frequency perception.

[2] For an analysis of the relations between music aesthetics and theories about the ear, see Erlmann (2010).

In the early 1880s, Félix Savart used a rotating toothed wheel to determine the range of hearing frequencies. Similar studies were conducted by William Hyde Wollaston (in 1820), ésar-Mansuète Despretz (in 1846, using tuning forks), and Francis Galton (in 1876, using a brass whistle later known as the Galton whistle). Establishing the amplitude limits from the minimally audible to the painful proved to be more challenging due to the lack of devices capable of generating quantifiable intensity units. Up until the emergence of electric circuits, experts relied on various types of hammers, tubes, and tuning forks. In 1885, Arthur Hartmann designed an auditory chart, using tuning forks to measure percentages of hearing. In 1903, Max Wien also used tuning fork stimuli to develop a sensitivity curve, in one of the earliest attempts to measure the relationship between intensity and frequency thresholds (Vogel et al. 2007, 82). Although these experiments were crucial for the construction of Ear 1.0, the lack of measurability remained an obstacle for the specialists.

The second representative group in the "New Acoustics" field came from physics and centered on the study of sonic behavior. This group included well-known figures such as Pythagoras,[3] Galileo Galilei,[4] Ernst Chladni,[5] and Pierre-Simon Laplace.[6] In 1862, Helmholtz published *On Sensations of Tone*, in which he identified the presence of upper partials along with a fundamental frequency. In that same year, Rudolph Koenig observed acoustic signals using an oscillating flame and a rotating mirror. Twenty years later, Baron Rayleigh used suspended disks to determine the amplitude of a sound source. At the turn of the twentieth century, Wallace Sabine's measurements of reverberation time and the absorption coefficient of different materials helped to consolidate the field of architectural acoustics (Thompson 2002). By instituting the field of acoustics, this group established yet another chain of reference connecting sound (now an object with specific properties) and hearing.

The final and third group of New Acoustics was made up of the sound media entrepreneurs who by the 1930s had already built telecommunication conglomerates with global ambitions. Drawing on experiments from the first two groups, these explorers helped to turn sonic events into stable object-signals that could be transmitted, stored, reproduced, and amplified. As Sterne notes, this process included three main events:

[3] Pythagoras used the monochord to identify frequency ratio relations.

[4] In the sixteenth century, Galilei used the pendulum and vibrating bodies to establish the relationship between frequency and pitch.

[5] In the eighteenth century, Chladni's vibrating plates made the nodal lines of soundwaves visible.

[6] In the 1810s, Laplace conducted a series of investigations about the speed of sound.

> (1) the emergence of audile technique as a way of abstracting some reproduced sounds (such as voices or music) as worthy of attention or "interior," and others (such as static or surface noise) as "exterior" and therefore to be treated as if they did not exist; (2) the organization of sound-reproduction technologies into whole social and technical networks; and (3) the representation of these techniques and networks as purely natural, instrumental, or transparent conduits for sound. (Sterne 2003, 25)

The 1870s was a particularly remarkable decade for sound media exploration. Trying to build a telegraphic device that could send multiple messages via tuning forks, Alexander Graham Bell started to work on the idea of transmitting sound information as a continuous rather than an intermittent current. In 1874, inspired by Koenig's manometric flame and Édouard-Léon Scott's 1857 phonoauthograph (a device that used an elastic membrane and a stylus to inscribe sound waves on glass or paper), Bell created an ear phonoauthograph by mounting human ear ossicles and an eardrum onto a wooden frame. Later in that same year, he started to conceive of the use of a diaphragm attached to an electric current in order to transmit sounds over distance.

In 1877, one year after Bell obtained his first patent for the electric telephone, Thomas Edison publicly announced his phonograph. Also drawing on Scott's phonoauthograph, the device could record and reproduce sounds engraved on a thin foil. In that same year, Edison won a patent for the microphone, which had two metal plates separated by granules of carbon. The device transduced sound pressure into electric signals by vibrating the granules, causing changes in electric resistance. Also in 1877, Ernst W. Siemens received a German patent describing what would later become the loudspeaker: a moving-coil transducer "with a circular coil of wire in a magnetic field and supported so that it could move axially" (Rossing 2007, 18). By the end of the nineteenth century, Edison had founded Edison General Electric (later the General Electric Company), and Bell had established a vast telecommunications complex, which included Bell Labs, the Western Electric Company, and the American Telephone and Telegraph Company (AT&T).[7]

The convergence of experts from medicine, physics, and telecommunication into New Acoustics was further consolidated in 1929 with the creation of the Acoustical Society of America. It is here that we will find the inauguration of Ears 1.0 and 2.0. As telephone lines started to spread, it became financially imperative to measure

[7] I am here less interested in reproducing a canonized narrative about inventors and inventions than in following figures whose *legal hold* over the production and distribution of these objects determined the economic power of the telecommunication conglomerates they set in motion.

signal loss over distance. In 1904, Bell Telephone Laboratories designed the MSC (Miles of Standard Cable) unit, with 1 MSC at 795.8 Hz being the slightest difference of intensity detectable by the average listener.[8] Tests suggested that "commercially acceptable speech was achievable over a connection of 46 MSC [. . .]; connections not more than 50 miles apart should be no worse than 30 MSC" (Ward 2006, 32). In 1924, the company replaced the MSC with the TU (Transmission Unit). This unit

> was a distortionless, logarithmic unit so chosen as to make use of common logarithms convenient in transmission computations. Its magnitude was very nearly the same as the loss of a mile of standard cable and, thus, existing experience learned in terms of miles of standard cable could be transferred to the new system with a minimum of difficulty. (Sullivan 1971, 2669)[9]

In 1928, the TU became the decibel (dB), with 0 dB (10^{-12} W of sound power) becoming the reference value. As the ratio between the weakest perceptible sound and the pain threshold is rather large (10^{12}), it seemed logical to convert these numbers into a logarithmic scale. The decibel is a practical device to express the difference between a reference value and a specific value to powers of 10. For instance, if you put ten identical washing machines in a room that had one machine, you would be multiplying sound pressure by 10 and increasing the sound level by 10 dB. Increasing the intensity by a factor of 100 corresponded to a 20-dB increase (a 30-dB increase would require 1,000 washing machines in the room). A change in the power ratio by a factor of 2 results roughly in a 3-dB variation. In other words, if you put twenty washing machines in a room that had ten machines, the sound level would increase by 3 dB.

If the decibel needs a reference value to operate, then what is the minimum threshold for the "average" listener? In the 1920s, AT&T continued to refine telephone communication by building Ear 1.0 through several audiometric surveys, a process Mara Mills refers to as the "ergonomopolitics of objects" (Mills 2011, 130). In 1922, Western Electric workers Robert Wegel and Edmund Fowler coined the

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[8] As Mara Mills describes, this research on the "just noticeable difference" (JND) between sounds drew on experiments by Edward Wheeler Scripture and Carl Seashore in the 1890s. Seashore developed the first commercially successful audiometer in the United States (Mills 2011).

[9] As John Hilliard explains, "The 'TU' also eliminated the problems associated with the mile of standard cable (which had been used for twenty years) which included [frequency response] distortion due to its inherent inductance and capacitance. The 'TU' could then be independent of frequency so that it could be used to measure power ratios at any frequency. The sound power changes that could be detected by the ear corresponded to the 'mile of standard cable.' The properties of the 'TU' made it available to other fields and was not restricted to telephone circuits" (Hilliard 2006[1984], 1).

term “audiogram,” showing the “variation of minimum audible sensitivity with frequency” (quoted in Mills 2011, 129). One year later, Western Electric produced the first widely-used audiometer (the Western Electric 2-A), which included eight frequencies, but lacked a calibration for amplitude levels. In 1933, Harvey Fletcher and Wilden A. Munson proposed average equal-loudness contours, based on a survey where subjects wearing headphones were asked to determine the equal loudness of pure tones in various frequencies, using a 1 kHz tone as the reference (Fletcher and Munson 1933). In retrospect, using 1 kHz as the zero-point proved not to be the best choice, as the human ear is most sensitive between 2 and 5 kHz, leading the chart to include negative decibel values. Between 1935 and 1936, the U.S. Public Health Service conducted a series of hearing surveys to establish the audiometric zero reference standard. In the 1950s, D. W. Robinson and R. S. Dadson proposed a re-determination of the equal-loudness contours (Robinson and Dadson 1956), which served as the basis for the international standard ISO/R 226 (1961). Their 1956 study proposed substantial changes to the Fletcher-Munson curves, with a discrepancy of up to 14 dB below 500 Hz. However, a 2003 revision of ISO 226, which relied on studies conducted in Japan, Germany, and Denmark with individuals between eighteen and twenty-five years old, showed that the 1933 Fletcher-Munson contours are in fact more accurate than the Robinson-Dadson curves, particularly in the higher frequencies (Suzuki and Takeshima 2004). In 2014, the Acoustic Technical Committee reviewed and confirmed the 2003 version of ISO 226.

With a (somewhat) stabilized Ear 1.0 and a workable quantification system in place, it became feasible to build Ear 2.0. For the anti-noise campaigners, who were eager to tame urban noise but still lacked an inscription device capable of bypassing the unreliable individual ear, Ear 2.0 was a game changer. In 1926, Edward E. Free conducted measurements across New York City by adjusting the pure tone of a Western Electric 3-A audiometer to equal the loudness of the measured noise (Thompson 2002, 148). In 1929, New York City’s Noise Abatement Commission conducted 10,000 measurements at 138 locations (Thompson 2002, 148).[10] In a 1930 article, Free described the “acoustimeter” recently developed by C. F. Burgess Laboratories, which provided “the most flexible, accurate and reliable method of noise measurement so far available” (Free 1930, 29). The device included a condenser microphone, vacuum tubes to pre-amplify the signal, battery boxes, and a galvanometer showing the readings in decibels. It captured sounds between 60 and 10,000 Hz, and between 0 and 120 dB. Drawing on research on equal-loudness contours, the acoustimeter included an electric network of condensers

[10] For a discussion of the New York City Noise Abatement Commission, see Wynne (1930).

and inductances that emulated human ear responses at different frequencies. The emulation was an approximation, as it would be "impossible to produce networks which will correspond exactly to any one definite curve drawn to represent the sensitivity of the human ear" (Free 1930, 27).[11] Additional filters could be attached to the device to measure noise at specific band frequencies (20–200 Hz, for example). These early sound level meters (SLM), however, were expensive, big, and heavy.[12] To further stabilize this inscription device, the Acoustical Society of America and the American Standards Association issued the "American Tentative Standards for Noise Measurements" in 1936. This standard specified, among other things, reference pressure values,[13] frequency responses, and SLM microphone calibration procedure (Barstow 1940, Scott 1957). The IEC (International Electrotechnical Commission) classified different types of SLM based on accuracy.

The working premise of a current SLM remains pretty much the same. Sound pressure is captured by an omnidirectional condenser microphone and amplified. The signal passes through a frequency-weighing network. As equal-loudness contours vary depending on intensity (they become flatter as intensity increases), SLMs include the "A" weighting (based on the Fletcher-Munson contours at 40 phons)[14] and the "C" weighting, which roughly follows equal-loudness contours at 100 phons (the "B" weighting at 70 phons is now rarely used). As environmental noise levels tend to oscillate, the constant needle movement of early analog models made it difficult for the user to assign a value. For that reason, besides the frequency weightings, SLMs also include time weightings. The RMS (root means square) circuit provides the average energy of the measured sound in three standard durations: Fast ("F," with time constant of 125 milliseconds), Slow ("S," with time constant of one second), and Impulsive ("I," with 35-millisecond response). Finally, a logarithmic circuit converts the RMS circuit signal to deliver the reading in decibels. Digital SLMs include filters for real-time frequency analysis in bandwidths of one octave and one-third of an octave. A hold circuit stores the peak pressure (without the RMS averaging) and the maximum RMS values. Particularly useful for environmental noise measurements, the equivalent continuous sound level (L_{eq}) can replace time weighting by capturing noise levels sixteen times a second and calculating the average.

[11] Like the equal-loudness contour studies, the weighting procedure was developed by the telephone industry to measure residual noise in telephone circuits.

[12] H. H. Scott explains that some models could cost more than an automobile, weigh 110 pounds, and measure 4 cubic feet (Scott 1957, 1331).

[13] At 1 kHz, 0 dB = 20 μPa.

[14] 40 phons = contours at 40 dB at 1 Khz.

Package all this in a sturdy plastic case, and you have Ear 2.0, an actor in sound-politics that has quickly become the most authoritative representative of Ear 1.0 and, by extensions, of our ears. For the most part, the SLM is embedded in scientific discourse as a black box that can transport data without deforming it. In that sense, the SLM went from a source of *controversies* (how can we define the minimum thresholds, find workable units, and develop time and frequency weighting circuitries?) to a source of *resolutions*: a tool able to correlate the acoustic world "outside" with the bodily ear "inside." With SLMs, governments can hold a factory accountable for protecting its employees from noise—in most countries the limit varies between 85 dB(A) and 90 dB(A) for an 8-hour time-weighted average. Besides disciplining businesses, they can also estimate the damage caused by noise in a population. The U.S. Department of Labor states that each year 22 million workers are exposed to potentially damaging noise at work, with "$242 million [. . .] spent annually on workers' compensation for hearing loss disability."[15] In the 1990s, governmental agencies created the "disability-adjusted life-year" (DALY) to calculate disease burdens and life expectancy as the sum of years lived with disability and early deaths in the population. In a 2011 report on the quantification of healthy life years lost in Europe, the World Health Organization estimated that environmental noise had caused an accumulated loss of "61,000 years for ischemic heart disease, 45,000 years for cognitive impairment of children, 903,000 years for sleep disturbance, 22,000 years for tinnitus, and 654,000 years for annoyance [. . .]" (WHO 2011, v).

Drawing on Latour, one can envision in Ears 1.0 and 2.0 the constant encounter of two modes of existence. The first, the scientific one, operates through what Latour refers to as *chains of reference*, made of "points along the way that make it possible to verify the quality of our knowledge" (Latour 2013, 79). From laboratory to laboratory, developing more precise surgical instruments, dissecting animals, testing the ear through a series of stimuli, adding measurability, establishing a taxonomy, investigating disorders and diseases, documenting and averaging the organism's responses, all this has led them to a remote entity: the human ear. The constant extension and refinement of this chain allows the specialists to establish the series of correspondences between sound and ear. It is through chains of reference that both can be patiently constructed as knowable objects.

The performance of the SLM is informed by its capability to emulate Ear 1.0. To do that, it must translate a series of acoustic principles found in the human ear, such as the transduction potential of the diaphragm, signal amplification,

[15] U.S. Occupational Safety and Health Administration, https://www.osha.gov/SLTC/noisehearingconservation/.

weighting, and complex wave analysis. To provide a value that can be easily understood, stored, and compared, the SLM embeds the decibel. In its turn, the decibel has become part of a meta-language in acoustics to describe sound power (in lieu of Watt), sound intensity (in lieu of Watt per square meter), and sound pressure (in lieu of Pascal). However, as a unit that expresses the ratio between relative and reference values, the decibel can only operate under an agreement on what this reference value should be—in our case, the minimum hearing threshold. As this reference moved from telephone circuitry to environmental noise, from pure tones to complex waves, and from tests within one country to international surveys, it became easier to circulate and compare data and harder (but not impossible) to destabilize this value.

The second mode of existence to which the SLM belongs is that of technology, which entails the folding of actors to dislocate action. "With the folding of technological beings," Latour explains, "a *dislocation* of the action emerges into the world and makes it possible to differentiate between *two levels*, the starting level and the one toward which you have precisely shifted gears by installing in it other actors who possess different resistances, different durations, different degrees of solidity" (Latour 2013, 229). As the previous chapter has suggested and other sound studies authors have shown (Bijsterveld 2008, Mills 2011, Sterne 2003), the institution of the SLM, with its capacity to fold in its circuitry a scientifically reliable version of Ear 1.0, has produced a dislocation of action. We now delegate to the device the act of hearing for us. As it replaces our ears as the authoritative hearing actor, our ears become the *effect* of this technology. In other words, by depending on the SLM to assess any sound according to a limited set of criteria (frequency and amplitude), our hearing becomes conditioned by what the SLM—a black box whose resistances and degrees of solidity are different from the human ear—can hear. Through the miniscule repetition of a series of exposures to sounds that are allowed to exist thanks to the SLM's validation, this technological being is able to reshape our eardrums, cochleae, and hair cells. Following Latour, we can say that, by hearing for us, the SLM envelops not only the Ear 1.0's protocol but also the future of our acoustic world.

The ABNT's Hybrid Forum

Equipped with some knowledge about Ears 1.0 and 2.0, we can now enter a large meeting room in São Paulo, where roughly thirty people are staring at a projected screen. The tables in the room form a big "U," at the center of which the coordinator is editing the projected document as others jump in with comments and suggestions. On his side, the secretary types up the minutes. As the hours pass in what has been a long day of deliberations, the coordinator expresses some frustration with the group's slow conversion rate of collective knowledge into technical guidelines: "Let's try to write these sentences so we can express what we're thinking, okay? It seems that what's slowing us down is Portuguese grammar."

But what else is there to do? Once one has a reliable Ear 2.0, isn't the task at hand to simply point the device at a sound source (say, a vehicle or a jackhammer) and write the results down in a report? If only! Using an SLM is not like using a radar gun, which requires one to simply point at an object to estimate its speed by calculating frequency changes in the emitted radar signal or laser pulse. Capturing a sound can be quite challenging because, as a mechanical wave traveling from point A to point B, sound can undergo a range of diffractions and refractions depending on atmospheric conditions such as wind and temperature. Once the specialists have Ear 2.0 as a reliable translator of Ear 1.0, the device is ready to leave the acoustics lab and enter into messier acoustic conditions. That, in turn, requires them to design a *protocol* for properly measuring sound.

This is what the experts in the meeting room are doing. They are here voluntarily working to revise two Brazilian Regulatory Standards (*Normas Brasileiras Regulamentadoras*, or NBRs). The Brazilian National Standards Organization (*Associação Brasileira de Normas Técnicas*, or ABNT), which we came across briefly in the previous chapter, is the country's accredited standardization organization. NBR 10151 (1987, last revised in 2000) deals with the "Assessment of Noise in Inhabited Areas, Seeking the Comfort of the Community" by establishing "the required conditions for assessing the acceptability of noise in communities, regardless of the existence of noise complaints." The other standard, NBR 10152 (1987), addresses "Noise Levels for Acoustic Comfort" for different types of rooms, such as surgery rooms in hospitals, hotel rooms, living rooms, and concert halls. For several years, the acoustics experts have been trying to publish a revision of those two standards. But while most in the room agree that the current version of the standards is outdated, few seem to agree on what exactly the new documents should look like. Some want to make substantive additions, whereas others want to change as little as possible. In any case, something *must* be done because the task is well overdue—ABNT bylaws state that unrevised standards are canceled after ten years.

But why not simply use an already existent noise measurement standard? Why not take advantage of the work already done by the American National Standards Institute, the British Standards Association, the *Deutsches Institut für Normung*, the *Association Française de Normalisation*, or the *Instituto Argentino de*

Normalización y Certificación? What about the ISO, the International Organization for Standardization? Wouldn't the most practical solution be to just translate the international standard? Many Brazilian specialists argue that a national standard is relevant because it takes into consideration local circumstances. Local standards are important stimulants for a country's scientific research and economic development. Technical standards are not pure conveyers of technical conventions. They are necessarily related to economic concerns as well. For instance, as I mentioned in the previous chapter, construction practices in Brazil have differed from those of European countries and the United States for historical, climatic, economic, and safety reasons. Inserting construction standards from another country in Brazil could undermine the country's civil construction economy and favor foreign companies, which could increase even more the price of property in Brazil. Too much protection from external competition, however, can counteract any incentive for construction companies to standardize their buildings and improve quality.

The ISO claims that its mission is to "make products compatible [. . .], identify safety issues," and share "technological know-how and best management practices" (ISO 2016, 4). The organization was founded in 1947, in a period when the Global North was consolidating other initiatives of international cooperation, including the International Monetary Fund (1944), the World Bank (1945), the United Nations (1945), and the General Agreement on Tariffs and Trade (1947). In the 1950s, ISO published "recommendations for international use," most of which focused on screw threads, rolling bearings, freight containers, pipe sizes, couplings, and power transmission (ISO 1997, 35). In the 1970s, the organization started to publish international standards rather than recommendations. ISO has now expanded from mechanical standardization to a range of issues, including organizational management (ISO 9000), environmental management (ISO 14000), and social responsibility (ISO 26000).[16] For electric devices such as SLMs, the International Electrotechnical Commission (IEC, founded in 1906) is the main reference for technical standards.

According to a report published by the ABNT, "the creation of a national standardization organization [in Brazil] ended up connected to civil construction" (ABNT 2011, 45). The ABNT was founded in 1940 as a private nonprofit organization with the task of assimilating foreign procedures and developing guidelines for producing and testing materials (e.g., cement, concrete, paints, and elevators). In 1950, the federal government issued a decree determining the use of NBRs in

[16] The book that you now hold in your hands is equipped with an International Standard Book Number (ISBN), established by the ISO in 1970.

its projects (ABNT 2011, 56). By the 1970s, the organization's membership included a list of powerful private and public institutions, such as the Federation of Industries of the State of São Paulo, the Brazilian Development Bank, the São Paulo State Energy Company, the Brazilian Petroleum Corporation (Petrobras), the Civil Construction Industry Union (Sinduscon), and Eucatex (ABNT 2011, 58). The period of military authoritarianism in the 1970s brought a series of maneuvers to nationalize the ABNT. Although such attempts were unsuccessful, they led to the proliferation of other regulatory agencies.

Today, the ABNT is a small nonprofit private fish in a sea of governmental agencies. The broad network to which it belongs is the National System of Metrology, Standardization, and Industrial Quality (*Sistema Nacional de Metrologia, Normalização e Qualidade Industrial*, or Sinmetro), which integrates several state and private institutions related to standardization and quality control. These include the National Council of Metrology, Standardization, and Industrial Quality (*Conselho Nacional de Metrologia, Normalização e Qualidade Industrial*, or Conmetro), and the National Institute of Metrology Standardization and Industrial Quality (*Instituto Nacional de Metrologia, Normalização e Qualidade Industrial*, or Inmetro).

Conmetro, a normative agency made up of several technical committees, is responsible for defining public policies related to standardization. One of its committees, the Brazilian Standardization Committee, delegates to the ABNT the creation of national standards. Inmetro is Conmetro's executive arm. It participates in ABNT's committees and provides technical support to other technical committees, testing products and procedures (in accordance with the NBRs), and providing accreditation for other testing labs. This threefold institutional model (an overarching system, a normative and an executive arm) is present in other governmental sectors as well. For instance, in 1981, the Brazilian government created the National System of the Environment (SISNAMA), which includes the National Council of the Environment (CONAMA, the normative arm), and the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, the executive arm).[17] Later in this chapter, we will see how some of these institutions are related to the revisions of NBRs 10151 and 10152. Without taking these governmental heavyweights into account, it is impossible to see why groups are so invested in the two standards.

Let us go back to the meeting room, which is taking place at the Sinduscon-SP[18] in downtown São Paulo. Here we already come across a first controversy. Why

[17] Another example would be the SNT (National Traffic System), created in 1997, which includes the National Traffic Council (Contran) and National Traffic Department (Denatran).

[18] Sinduscon was one of the earliest ABNT members.

are most of the ABNT meetings in São Paulo? Some participants defend having the meetings in São Paulo because it is a central location for those living in other regions and has a well-connected (and noisy, as we know) airport. Others complain that the choice of São Paulo is a strategy to keep the revisions closer to the construction sector and away from governmental agencies such as Inmetro and IBAMA, both of which are based in Rio de Janeiro. In 2012, when an expert from the state of Minas Gerais took over the coordination of the revisions of the two standards, the issue was raised once more, and it was decided that the meetings should be more inclusive and take place in other cities. As I show below, this change would soon cause turmoil.

The participants at the meeting are part of the of Acoustics Performance Studies Commission (henceforth the Acoustics Commission), one of the many commissions under the ABNT's Civil Construction Committee. As we take a seat at the table, someone hands over the attendance sheet. Beside columns for name and institution, the sheet asks participants to indicate their "class." This is not uncommon in standardization organizations, which operate thanks to volunteer work and aim to represent society more broadly by including experts, private organizations, state representatives, and laypersons. The sheet shows three classes of participants: "Neutrals," "Producers," and "Consumers." The categories seem to make more sense for the standardization of products such as lamps or screws, where it easier to distinguish manufacturing companies, research and governmental institutions that study and regulate lamps and screws, and groups that buy lamps and screws. For the Acoustics Commission participants (myself included), this classification was not always clear. Who exactly are the consumers? Due to this lack of certainty, and based on what I observed during the meetings, I propose that we organize the participants into five groups.

GROUP 1: SCHOLARS AND TECHNICAL INSTITUTIONS

This group is closer to the "Neutral" class. It includes university professors in departments of physics, civil engineering, electrical engineering, and architecture. It also includes representatives of testing materials/procedures institutions such as the IPT (see Chapter 1) and Inmetro. This group operates within research institutions and tends to push for accuracy, whether technical (the best measurement procedure), technological (the best equipment), or scientific (the best analytic protocol and terminology). The Brazilian Acoustical Society (SOBRAC, founded in 1984), which has served as an umbrella for acoustics scholars in the country, is an important institution attached to this group.

GROUP 2: LAW ENFORCEMENT AGENCIES

Standards express what experts in a given field agree to be the best practices. It is a recommendation, not an imposition. The weight of a standard, therefore, depends on how much legal power the government gives it. In 1990, CONAMA issued Resolution No. 1, which states that any noise above the limits established by NBR 10151 is to be considered harmful, and that construction projects should follow NBR 10152. We saw that, as a normative council, CONAMA deliberates practices that other agencies should follow. Through CONAMA's Resolution No. 1, the two NBRs have been embedded within numerous state and municipal noise laws. As the transcriptions of the meetings below make clear, the revisions would look different if CONAMA had not created this powerful link.

Group 2 includes members of the Environmental Agency of the State of São Paulo (CETESB), the municipal anti-noise agencies, IBAMA, and the State Public Prosecutor's Office. They are closer to the "Consumer" class because they deal with noise complaints through inspections, fines, and litigation. Whereas Group 1 is concerned with scientific precision, Group 2 is particularly attentive to the legal ramifications of the revised norms and the impact they will have on their modus operandi. To what extent, they ask, is it worth creating legal instability in the name of technical accuracy?

GROUP 3: SERVICE PROVIDERS

These are acousticians (mostly engineers and architects) in the private sector. They are invested in the revisions because it directly affects their jobs, which include conducting measurements, writing technical reports, and designing and implementing soundproofing projects. If Group 1 is concerned with scientific accuracy, and Group 2 with the standards' legal and budgetary ramifications, Group 3 sees these revisions as an opportunity to expand their business and consolidate an "acoustic mentality" in the country.[19] Together with Group 1, they believe the revisions can stimulate growth in the field of acoustics. One major challenge, however, is the lack of professionalization channels—in the early 2010s, the country had only one undergraduate program in acoustical engineering. ProAcústica (Brazilian Association for Acoustic Quality), which I include in this group, has been coping with this deficit by organizing several intensive courses in environmental acoustics. ProAcústica was created in 2010 and brings together acoustic

[19] We saw in the previous chapter that this "mentality" discourse has been floating around at least since the 1950s with the Brazilian Acoustics Institute.

engineers and soundproofing and construction companies—most of them based in São Paulo. As a result, ProAcústica should also be included in Group 4.

GROUP 4: PRODUCT PROVIDERS

This group includes companies that produce noise measurement hardware, software, and soundproofing materials. Like Group 3, they are directly affected by the revisions and expect them to increase sales. One of the main providers of SLMs in Brazil is 01dB,[20] the acoustics branch of the ACOEM Group—a French company founded in 1996 that focuses on environmental measurement, analysis, monitoring, and control. Nicolas Isnard, ACOEM's business manager in Brazil, explains that the development of SLMs took off in France in the late 1980s, with the stimulus of new legislation and standardization. 01dB has sold SLMs to several governmental agencies in Brazil, including the CETESB and the São Paulo Anti-Noise Agency (*Programa de Silêncio Urbano*, or PSIU). In the early 2010s, it was pushing for the introduction of acoustic simulation software to develop noise maps, a topic to which I return in the next chapter.

Another important actor in this group is São Paulo-based AtenuaSom,[21] one of the pioneers in Brazil in the soundproofed windows market. The company's biggest innovation is a technique for mounting a noise-canceling window onto an existent window. Recently, it started to test its windows using a holographic system, in which it is possible to visualize the soundproofing potential of different sections of window frame systems. Both 01dB and AtenuaSom are founding members of ProAcústica.

GROUP 5: NOISEMAKERS

These are private and public entities that participate in the revisions because their activities involve a certain amount of noise. Actors in this group include the Brazilian Association of Highway Concessionaires, the National Association of Railroad Transportation, the São Paulo Subway Company, the Federation of Industries of the State of São Paulo, the São Paulo Metropolitan Train Company, Vale S.A. (the largest producer of iron ore and nickel in the world), and the National Steel Company (*Companhia Siderúrgica Nacional*, a major steel producer). These actors are particularly interested in keeping the meetings in São Paulo, where they can monitor the revisions more easily.

[20] http://www.01db.com/pt-br
[21] http://atenuasom.com.br

I also include here Sinduscon and the Housing Union (Secovi),[22] both representatives of the construction sector. As we saw in the previous chapter, construction companies not only generate noise when assembling buildings but rely on questionable construction conventions when it comes to soundproofing. More recently, some companies started to see the improvement in their buildings' acoustics as a viable marketing strategy. They were particularly invested in another ABNT standard, NBR 15575 (published in 2013). This standard draws on ISO and establishes three noise transmission performance levels (minimum, intermediary, and superior) for construction systems (elevators, pipes, exhaust hoods, fans, etc.) in residential buildings. For Peter Barry, a senior expert at the IPT, "NBR 11575 is mostly about engineering. It deals with material performance, as opposed to NBRs 10151 and 10152, which deal with people" (personal communication, January 2017).

Table 2.1 gives a summary of the groups.

TABLE 2.1.

Five groups regularly present at the Acoustics Commission meetings for the revision of NBR 10151 and NBR 10152.

Group 1	Scholars, SOBRAC, Inmetro, IPT
Group 2	Law enforcement agents (CETESB, IBAMA, Public Prosecutor's Office, municipal agencies, etc.)
Group 3	Service providers (ProAcústica and acoustics companies)
Group 4	Product providers (01dB, AtenuaSom, etc.)
Group 5	Noisemakers (construction, traffic, mining, etc.)

In 2013, in a major push for the autonomy of the field in Brazil, members of the Acoustics Commission created the Acoustical Studies Committee, separating their activities (and the field of acoustics) from the Civil Construction Committee. They then tried to move NBRs 10151 and 10152 to the newly created Acoustics Committee. As the minutes of the meetings show, the Construction Committee strongly opposed this move, accusing the acousticians of a "lack of political awareness."[23] At what quickly became a tumultuous meeting, the Construction Committee representative explained that real estate companies and other "important entities in the country"[24] were deeply concerned about the impact that

[22] Although there is some overlap between the two organizations, Sinduscon includes construction companies, whereas Secovi is centered on real estate development companies.

[23] Minutes of the Meeting No. 11, NBR 10152 (Nov. 21, 2013), p. 4.

[24] Ibid.

the revised standards would have on urban planning. Using their administrative prerogative as the original holders of NBRs 10151 and 10152, the Construction Committee rejected the move and kept both standards within its territory.

In what follows, I consider six other controversies that emerged regularly during the meetings. These controversies illustrate the dynamics between the five groups and how specific issues moved back and forth between technical and social issues. I show this interaction by quoting exchanges between participants at the meetings I attended in 2012 (shortly after the Acoustics Commission meetings restarted with the new coordinator). This information is complemented with minutes from meetings I did not attend between 2011 and 2017. I do not identify the name of the individuals—just the group and institution he or she represents.

CONTROVERSY 1: PRESENT VS. ABSENT RECEIVER

COORDINATOR (GROUP 3): *NBR 10151 is going to establish measurement procedures near the property. If the objective is to create a technical report about the noise impact on a residence, you need to measure noise at the façade of the building—that's what 10152 is about. So we will have these two possibilities, but it's not our responsibility to determine how the authorities are going to use these standards.*

STATE PROSECUTOR (GROUP 2): *When you leave this undefined in the standard, the attorney is going to define . . .*

COORDINATOR: *Yes, interpretations are going to arise. This is a technical standard. We need to predict both situations.*

CETESB AGENT (GROUP 2): *The state prosecutor reads what the standard says and asks for things because the standard allows it. We are tired of being asked to measure things that are impossible to measure! You need to define in the standard that it does not apply to a given type of problem. The prosecutor makes us measure sound near a property, even when the community is 100 km away. So, you are going to penalize the property when there is nothing around it? You can't penalize a factory that is in the middle of nowhere.*

COORDINATOR: *If you define an area for environmental preservation, you need to establish noise limits as well.*

CETESB AGENT: *But you can make things stagnate that way. What about sugar and ethanol production here in the state of São Paulo?*[25] *If you apply this version of 10151 to measure noise limits, you are going to close all refineries!*

[25] Brazil is one of largest producers of ethanol fuel in the world.

METRO-SP REPRESENTATIVE (GROUP 5): *The point is not to give the opportunity to anyone to misuse the standard . . .*

ACOUSTICIAN (GROUP 3): *The 10151 needs to be a standard for outdoor environments to provide guidelines for projects, reducing noise impact and promoting sustainability. A factory can be in the middle of nowhere now. But urban planners might predict the emergence of a community next to industrial noise. We need to have this very clear. If we focus on the receiver only, we won't provide parameters for construction projects and urban planning. We will be just saying, "Let's wait to see what happens."*

METRO-SP REPRESENTATIVE: *The CONAMA resolution focuses on acoustic comfort, so it's about the receiver. The public sector should define the parameters and whether there will be urban expansion close to my traffic line project.*

ACOUSTICIAN: *Yes, the public sector will define the parameters based on the standard . . .*

COORDINATOR: *We already have twenty-three pages and there is a lot more to be done. This standard is going from four pages to almost forty pages. We are trying to let the debate flow here so we can have consensus.*

ACOUSTICIAN: *I suggest that we decide now if this standard is going to depend on the receiver or if it will address the noise impact regardless of the receiver. We need to settle this issue.*

COORDINATOR: *We will have infinite applications of this standard. It is important to make it cohesive, but some issues don't have to be decided now. We have very different situations in Brazil. We need to recognize CETESB's work against noise pollution here in São Paulo. Most of the topics discussed in this standard are obvious for us because we are experts. But for a layperson, the document is going to be the technical reference. We need to be careful.*

CETESB AGENT: *If you are going to build a residential building next to a noisy road, you must provide the necessary acoustic protection. Of course, that doesn't mean that the sound source can disrespect the limits. But whoever is arriving there afterward needs to anticipate protection measures because they are making use of that infrastructure.*

Part of the challenge here is that the Acoustics Commission was working on two complementary NBRs at the same time. Not only that, but the commission was expanding the documents considerably to include much more detailed measurement procedures and analytic criteria than the pre-existing versions. They were aware that such a move could risk allowing nonexperts, such as attorneys and lawmakers, to "misuse" the standard. The acoustician was pushing for a more proactive approach to the standards. Rather than focusing on the receiver as a parameter for defining sound pressure limits, the acoustician wanted the standard to become a determinant for the construction of hydroelectric plants, factories, highways, and other large development projects in the future.

This controversy relates to two different approaches to noise control: the passive approach, which deals with noise control based on the proximity to an existent receiver; and the active approach, which focuses on planning and establishes mechanisms for controlling noise regardless of the presence of a receiver. The active approach can have high implementation costs and is an effective tool for holding governments accountable for preserving acoustically sustainable spaces. An example of an active approach is that of noise maps, which describe sound propagation across an area and help define how much traffic or industrial activity that area should allow in the future. A good example of a passive approach is the São Paulo anti-noise agency, which, as we will see in Chapter 4, operates based on complaints.

CONTROVERSIES 2 AND 3: SCOPE AND TRAFFIC

COORDINATOR: *The objective of NBR 15152 is to provide a measurement methodology. You measure at least three points in rooms with up to 300 cubic meters and additional points in larger rooms. In small rooms, one of the points measured needs to be in the corner. This is the methodology for diffuse acoustic fields.*[26] *You can measure with the windows open, windows closed, A/C on or off, and with the room empty or furnished. The professional is going to decide that, depending on the circumstances.*

SCHOLAR 1 (GROUP 1): *So it is not "independent of sound sources" as the document says.*

IPT REPRESENTATIVE (GROUP 1): *It is because we're measuring a room independently of any specific source. In the end, we are measuring the acoustic comfort—in those conditions and with those sources.*

SCHOLAR 1: *This matter of environmental impact is a problem. NBR 10151 refers to external sources. NBR 10152 deals with noise coming from the building.*

IPT REPRESENTATIVE: *You are measuring the overall noise in the environment. The source can be external, such as traffic, but you are not assessing the impact of traffic noise with 10152. You are simply assessing the comfort* inside *the room.*

[26] A diffuse sound field is a reverberant sound field in which the sound is more evenly distributed. A direct sound field, on the other hand, is sound in open space, without reverberation.

COORDINATOR: *If a train from the São Paulo Metropolitan Train Company is passing by, the purpose is not to assess its noise. It is important to highlight that this standard does not apply for environmental impact assessment.*

SCHOLAR 1: *But the environmental impact can be internal, too. We need to define that.*

SCHOLAR 2: *We could put "assessment of sound levels generated by sources outside the building."*

IPT REPRESENTATIVE: *The source doesn't matter!*

PROACÚSTICA ACOUSTICIAN (GROUP 3): *I think you are protecting the traffic infrastructure that way. This is a double-edged sword. You are going to have occasions in which the infrastructure will never be able to conform to NBR 10151. But you still could improve the soundproofing in the façade of the building that is exposed to traffic noise. It's much simpler than changing the traffic network.*

COORDINATOR: *We need a standard to assess and characterize a project, such as rail traffic. And we need a standard to assess and characterize an environment like the meeting room we are in right now, according to its use. These are two different things. We go back to that debate on responsibilities. Should the train company be held accountable? Or should the construction company that built the building be held accountable, knowing that the building is next to the railroad and it would be a meeting room? This needs to be clear. 10152 won't assess the impact of infrastructure. If during [sound] measurement, the train is a problem, I can't make the train company accountable. That's the construction company's fault.*

This exchange illustrates two heated controversies. The first one is the question of scope. As the same group of experts was revising two environmental noise standards at the same time, they were often unsure what each standard was supposed to do. The idea was to make NBR 10151 a standard for measuring the environmental impact of specific sound sources so that it could serve as a guide to urban planning. NBR 10152, however, was to be used simply to establish whether the noise level of a given room adhered to the limits for that type of space. The confusion was mostly about sounds coming from within the building. Which standard should be used to measure the noise made by a neighbor in the apartment above? After much discussion, the Acoustics Commission suggested that this issue could be resolved by framing NBR 10151 as a standard for measuring noise outside a given room instead of noise outside the building.

The second issue is traffic noise. In the previous chapter, we saw that traffic noise, including the minhocão and the Congonhas airport, has been one of the most contentious issues in São Paulo. We also saw that several noise ordinances provided a loophole for traffic. João Baring, one of the founders of the IPT acoustics lab and the coordinator of the Acoustics Commission in 2010–2011, considered traffic noise the most controversial point of the revisions. The strongest argument for excluding traffic noise from NBR 10151 was that, unlike stationary sources, which spread spherically, traffic noise spreads cylindrically. Measuring it using the procedures of NBR 10151 would yield incorrect results. At the same time, many experts argued that it would be absurd to leave out such a relevant source of noise pollution. This has been a delicate issue because NBR 10151 (2000) establishes that "if the background noise is higher than the numbers included in [the table] for the area and time considered, the criterion becomes the background noise." In other words, as the predominant and continuous source of noise in urban areas, traffic noise often became the reference value for measuring *other* noises.

In 2012, railroad, road, subway, and aircraft private and public organizations committed to creating standards for each type of traffic noise. Some experts found it questionable, however, that Group 5 would be in charge of drafting the standards for measuring their own noise. Others objected that, unlike NBRs 10151 and 10152, these new traffic noise standards would not have the powerful link to the CONAMA's Resolution No. 1/1990. In 2013, after heavy criticism, the Acoustics Commission decided to incorporate traffic noise into the standard by dividing NBR 10151 into two parts: one for general use (i.e., for inspections), and another for specific uses (air, waterway, rail, metro, and road traffic noise measurement). However, a few years later the Acoustics Commission changed its mind again, reverting to the idea of having separate standards for traffic noise.

CONTROVERSY 4: DECIBEL VALUES, PERIODS, AND ROOMS

COORDINATOR (GROUP 3): *In large urban centers, we are recommending that daytime last between 7:00 a.m. and 10:00 p.m., and nighttime between 10:00 p.m. and 7:00 p.m. In small cities, we recommend between 7:00 a.m. and 8:00 p.m. for daytime, and 8:00 p.m. and 7:00 a.m. for nighttime.* [He reads the draft] *"For the application of this standard, nighttime must not last less than eight hours, must not begin after 11:00 p.m., and must not end before 6:00 a.m." That is to give some flexibility to industrial areas. Personally, I think the standard shouldn't include any timetable or decibel values. That is the responsibility of CONAMA, municipal governments, etc.*

SLM COMPANY REPRESENTATIVE (GROUP 4): *Why does this standard include a timetable?*

IBAMA AGENT (GROUP 2): *We had a demand from the population. We were receiving complaints from Salvador in relation to carnaval sound trucks. The policing agencies didn't know what to do or what periods to establish. That was twenty years ago. . . . We needed to provide some parameters.*

INMETRO AGENT 1 (GROUP 1): *Don't change that table. When we have a law to create noise maps, then we can change the standard. Let's not forget that this is the only standard in Brazil that has the status of law!*

COORDINATOR: *I really don't think we should put this to a vote . . .*

INMETRO AGENT 2: *We did not go to most meetings in São Paulo. You would put this to a vote if we were absent, and now you can't put it to a vote because the others are absent?*

COORDINATOR: *Previous meetings had more than thirty people on average. The idea was: since we are changing the standard, let's fix what's broken. This is broken. We are assessing two long periods, daytime and nighttime, recognizing the possibility that municipalities could use an additional time band . . .*

IBAMA AGENT 1: *Did anybody oppose the 10:00 p.m. daytime limit in previous meetings?*

COORDINATOR: *I did. The industrial sector needs some flexibility . . .*

INMETRO AGENT 1: *That is a political decision! If you change the time, you are going to penalize the lower classes, people who have to wake up early to take buses and drive across the city.*

[Tumult; several people talking at the same time]

COORDINATOR: *The logic is: you make the change. If society disagrees, they are going to say so, and we go back to how it was.*

INMETRO AGENT 2: *No! The opposite makes more sense. If society wants the change, we make the change. You should only change it if there is some technical justification.*

COORDINATOR: *There is no technical justification for nighttime to be from 10:00 p.m. to 7:00 a.m. The commission made that change. We will write this standard from scratch; it's not the same standard.*

INMETRO AGENT 1: *You can't make a standard for a few Brazilians only!*

COORDINATOR: *We are only saying that if a municipality establishes the time periods, nighttime shouldn't be less than eight hours and shouldn't start after 11:00 p.m. and end before 6:00 a.m. This document was written in São Paulo.*

INMETRO AGENT 2: *A controversial issue like this should have been put to a vote.*

COORDINATOR: *It's only controversial for you! If it were controversial to anyone else, it would have been voted on, and it would be in the minutes. All I'm asking is . . . Let's leave it like it is and see what happens in the national consultation.*

> *I'm really worried about making this change. That is why I asked to put in the minutes that the consensus was to keep this part as it was decided in São Paulo. That way I protect myself, too . . .*

The NBR 10151 noise limit/daytime/zone table has been perhaps *the* most contentious issue among the Acoustics Commission participants. Many experts agree with the coordinator that a standard should not include noise limits and timetables and should leave that issue to municipal noise ordinances. Then again, as the Inmetro agents are quick to point out, the CONAMA resolution gives these standards considerable legal weight; leaving the table out at this point could generate legal instability. The IBAMA official, who was involved in the creation of the first version of NBR 10151 in 1987, explains they included the table in the standard because they were receiving several noise complaints and inspection agencies did not know what parameters to use. At previous meetings in São Paulo, the Acoustics Commission had reached an agreement about making some changes to the timetable to give cities some flexibility. However, to the coordinator's dismay, the consensus suddenly evaporated when the meeting took place in Rio de Janeiro, where IBAMA and Inmetro are headquartered. One particularly contentious issue about the NBR 10151 table was the noise limits in rural areas (see Table 2.2), which

TABLE 2.2.

NBR 10151/2000 decibel values suggestion for daytime and nighttime according to area type. All values in dB(A).

Area Types	Daytime (7:00 a.m.–10:00 p.m.)	Nighttime (10:00 p.m.–7:00 a.m.)
Farms and ranches	40	35
Strictly residential urban areas; areas near hospitals and schools	50	45
Mixed-use, predominantly residential	55	50
Mixed-use area, with commercial and administrative potential	60	55
Mixed-used area, with recreational potential	65	55
Strictly industrial areas	70	60

Group 5 considered too low and an obstacle to industrialization in Northern and Center-West Brazil.

NBR 10152 also includes a table. It establishes a range of decibel values acceptable for different room types (e.g., hospital nurseries, hotel restaurants, and school libraries). But while some in the Acoustics Commission wanted to make the NBR 10151 table more flexible, others wanted to make the NBR 10152 table more restrictive. "The construction company lobby is very powerful," explained a senior acoustician who had followed the unsuccessful attempts of previous revision commissions to change the NBR 10152 values. A particularly contentious issue related to this table is that, in 1990, the Ministry of Labor issued the Ministerial Order 3751, which refers to the NBR 10152 table to determine noise exposure limits in the workplace.

CONTROVERSY 5: MEASUREMENT

COORDINATOR (GROUP 3), READING THE NBR 10151 DRAFT: *"The distance between the microphone and any reflective surface besides the floor needs to be at least twice the distance between the microphone and the sound source's dominant surface." Should we keep this? That is from ISO 1996 . . .*

IPT REPRESENTATIVE (GROUP 1): *That's because when the sound passes through the microphone the propagation is more uniform, more spherical.*

COORDINATOR: *Correct. . . .*

IPT REPRESENTATIVE: *But that depends on the frequency. I suggest we establish two conditions: either measuring two meters away from any surface or with the microphone on the façade. At two meters, there is no correction, and on the façade, you take out 6 dB. Intermediate positions increase the level of uncertainty, which can be a problem for inspection.*

SCHOLAR 1 (GROUP 1): *To make things easier, we could include the possibility of measuring one meter from the window, so that the technician would be able to stretch his arm out the window.*

SCHOLAR 2 (GROUP 1): *But who has a one-meter arm?*

SCHOLAR 1: *Everybody!*

COORDINATOR: *We excluded the measurement procedure from NBR 10151 in which you could measure inside the complainant's room. That procedure was criticized because it was subject to the room's acoustic field.*

CETESB AGENT (GROUP 2): *We from CETESB oppose changing the measurement procedure. Which side are you on? We defend the people; the individual who cannot enjoy his property because there is a noisy factory. The ISO standard* *was designed for European buildings that have soundproofing. By changing the procedure, you are removing the policing power from the state agencies. That is extremely important for us because we will not be able to satisfy any complainant by measuring noise outside his room.*

COORDINATOR: *This is a commission with representatives from all parties concerned. We need to find a balance to reconcile these issues in order to avoid privileging one specific sector. We all will have to adapt.*

SCHOLAR 1: *I understand CETESB's concern in the sense that this change can make a difference subjectively. Complainants like to see the inspector taking measurements where the nuisance takes place (in their bedroom, in the office, etc. . . .).*

Measurement procedures were another highly contentious topic. NBR 10151/2000 includes the procedure where the technician measures sound pressure levels in the complainant's room. According to the standard, the technician should subtract 10 dB(A) from the values in the table when measuring inside the complainant's room with the windows opened. Experts from Groups 1 and 3 argued that measuring an external sound inside the room was too unreliable due to reverberations. The idea, then, was to limit 10151 to noise measurements outdoors, where sound propagation is more diffuse. Group 2 strongly opposed this change, claiming that measuring outside the building would create a problem when the noise source was inside the building (e.g., a bar or nightclub on the ground level).

After much pressure from Group 2, the Acoustics Commission decided to leave in the option for measuring inside buildings with the windows open and subtracting 5 dB(A) from the table values in case of structure-borne noise. This, in turn, led to another disagreement on how the technician would be able to distinguish between airborne and structure-borne noise during an inspection. Another disagreement was the type of SLM the document should require. Groups 1, 3, and (obviously) 4 wanted to require more accurate devices (with frequency-spectrum analysis) and more regular calibration than suggested in the existent standards. Group 2 reacted strongly, claiming that this would be too costly for inspection agencies and require additional training.

CONTROVERSY 6: VOCABULARY CHANGES

SENIOR ACOUSTICIAN (GROUP 3): *I'm worried about nontechnicians using this standard. This is a revision of a previous standard. The previous standard included "acoustic comfort" in its title; technicians and nontechnicians understand what it is about. When we change the title to "sound pressure level,"* *nontechnicians won't understand that it's about acoustic comfort. We should find a way to link the old standard with the new.*

SCHOLAR (GROUP 1): *In the 1970s and 1980s, I was in favor of making super-simple standards, almost like an instructional booklet, for easy assimilation. But now the nature of it has changed.*

SENIOR ACOUSTICIAN: *People are going to look for a noise standard and are not going to find it. It's "sound pressure level" now, not "noise."*

SCHOLAR: *Those interested in assessing noise in any environment, indoors and outdoors, will have to study the topic.*

SENIOR IPT TECHNICIAN (GROUP 1): *In discussions about performance standards, the word "comfort" was the most controversial one. This is more common in the thermic field, where you have measurements based on satisfied people. They thought discussing comfort was complicated because it is a technical standard. Acousticians adopted that approach, too. . . . We can add "comfort" somewhere in the body of the standard, but it shouldn't be the focus. The focus is that there is a parameter, and we are going to measure it and have criteria to face up to it. That is the concept of "technique."*

STATE PROSECUTOR (GROUP 2): *Attorneys and lawyers use the word "comfort" because that is the major demand today in Rio de Janeiro. We have to understand that this will cause an impact. There are several ongoing lawsuits related to comfort.*

SCHOLAR: *I'm against "acoustic comfort." It's too subjective.*

One final controversy worth mentioning is the proposition to eliminate the terms "noise" (*ruído*) and "acoustic comfort" (*conforto acústico*) from the standards. The experts wanted to remove "subjective" and "nontechnical" terms. Because of this general concern, NBR 10151's title changed several times during the revisions. Its 2000 version, "Evaluation of Noise in Inhabited Areas Aiming for the Comfort of the Community," was later replaced with "Measurement and Evaluation of Sound Pressure Levels in Outdoor Environments." With the discussions about indoor measurements (Controversy 5), the title changed to "Measurements and Evaluation of Sound Pressure Levels in Inhabited Areas." NBR 10152 went from "Noise Levels for Acoustic Comfort" to "Measurement and Evaluation of Sound Pressure Levels in Indoor Environments."

Although the senior acoustician believed that *ruído* should be maintained in the title because it relates to the English word "noise" and is easier to understand, others insisted that it was too subjective. Many seemed eager to make the standards the mark of a new era of professional acoustics in Brazil, where those dealing with noise measurement "would have to study." They argued that the only way to improve the acoustics of Brazilian cities was to consolidate a workforce capable of generating accurate and stable facts. From now on, technicians should refer to the SLM as a *sonômetro* rather than the popular *decibelímetro* because the device doesn't measure decibels, but rather sound pressure levels. By 2016, it seemed clear that the field of standardization in acoustics had grown considerably in the country. The newly created Acoustics Studies Committee was overseeing several workgroups to revise, resurrect, translate (from the ISO), and create a wide range of standards about sound barriers, terminology in acoustics, indoors acoustics, musical acoustics, acoustic treatment, audiometry, and electroacoustic instrumentation. This suggests that the experts have in fact moved from noise measurement procedures into broader debates concerning Ears 1.0 and 2.0.

Like other standardization organizations, the ABNT operates via consensus. Once the experts reach an agreement about a standard, the draft then goes to public consultation online, where the broader public is invited to provide feedback and vote either for or against its confirmation. After analyzing the votes, the ABNT decides whether to send the document back to the Commissions for further revisions. Since 2013, the Acoustics Commission has submitted different versions of the two standards for national consultation, but each time it has failed to receive enough favorable votes. By 2017, only NBR 10152 had successfully made through the national consultation.

Michel Callon et al. (2009) define as "hybrid forums" public spaces where a heterogeneous group of actors meets to decide the best options for the collective across different fields of expertise. This process entails the conception of a state of the world inhabited by human and nonhuman entities. The authors argue that science is incapable of defining all possible worlds, simply because many uncertainties prevent a group of experts from identifying all entities at play—and hence all outcomes. The controversies at the ABNT meetings discussed here show the challenges of "establishing a clear and widely accepted border between what is considered to be unquestionably technical and what is recognized as unquestionably social [as] the line describing this border constantly fluctuates throughout the controversy" (Callon et al. 2009, 25).

Which actors in the Acoustics Commission get to define where this fluctuating border lies? Which entities should be included in the normalization of noise measurement procedures? What state of the world do they want to create through temporary agreements officially inscribed in audiometric charts, microphone circuitries, and technical standards? Should the standard *passively* describe or *actively* prescribe a given acoustic environment? Should the experts recognize the standards' ramifications within political circles, legal channels, and administrative flows, or should they stick to rectified knowledge of scientific chains of reference? The ABNT debates highlight the connections between hybrid forums and sound-politics. Meeting after meeting, the Acoustics Commission moved back and forth between the technically accurate and the politically and legally relevant. In trying to mobilize the revisions in a certain way, each group strategically highlighted specific attachments between the document and the world "out there."

As the frameworks provided by science and technology are not definitive, the question becomes how to deal with the overflows created by the hybrid forums. "All, specialists included, think they have clearly defined the parameters of the proposed solutions, reckon they have established sound knowledge and know-how, and are convinced they have clearly identified the groups concerned and their expectations. And then disconcerting events occur" (Callon et al. 2009, 28). The decision of whether to include traffic and construction noise is an example of overflow, in which the barriers containing a technical framework fall apart. Both construction and traffic noise groups have used their economic and political weight to break away from chains of reference linking their activities with noise control measures. At the same time, note that not even Ears 1.0 and 2.0, the building blocks of noise measurement procedures, are definitively stabilized. They too go through their own overflows each time new studies suggest existing technical inaccuracies and further revisions in equal-loudness contours and SLMs.

At the Acoustics Commission, the traffic and construction sectors entered the meetings and secured their places in the decision-making process by creating a collective and organized voice. The construction sector, which has been central in the history of standardization in the country, has maintained institutional control over the two standards. At the core of the country's construction hub, and away from Brasília and Rio de Janeiro (two national political centers), the governmental agencies struggled to participate in the meetings and were usually a minority. When that issue overflowed, and it became impossible not to include those noises in the technical standards, they made sure the specialists understood the political implications of their techno-scientific endeavor. The traffic group, on the other hand, reversed the strategy and lobbied for an even *more reliable* chain of reference, claiming that the propagation of sound in traffic is different from stationary sources and would thus require specific measurement procedures.

NBR 10151 will continue to lurk throughout the book. Lawmakers will refer to it to change or propose laws, law enforcers will apply it when inspecting bars, and judges will quote it to justify their sentences. Entangled in other controversies centered around other modes of existence and accessing these two technical standards from afar, other groups assume the NBR 10151 and 10152 are solid black boxes that can transport information between our human ears and the SLM screen seamlessly. However, as this chapter showed, under closer examination, the terrain of standardization in which the experts navigate is fairly slippery and highly mediated. If, as a modernist project combining different lines of inquiry (from physics, medicine, and telecommunication), New Acoustics has provoked a crucial shift in noise control debates, establishing and securing the chains of reference and technological folds that allow governments to do sound-politics remains open to heated discussion.