

# **Music, Noise and Silence: Defining Relationships between Science & Music in Modernity**

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## **Introduction: Developing a Research Network**

In February, March and April, 2015, the Science Museum, in partnership with the Royal College of Music and Nottingham University, organised three, two-day workshops, bringing together fifty-three researchers, writers, musicians and acousticians from across the U.K., Europe and North America. A full list of participants is given in **Appendix A**. The aim was to examine music and sound in relation to science and technology within the context of sonic modernity, at the same time exploring the structure and outline of a new touring exhibition around the theme of science and music. The participants were asked to consider how the cultural and historical categories of music, noise and silence could be used to structure the proposed exhibition, in the light of recent work in sound studies, musicology and history of science and technology. The involvement of leading researchers and practitioners in the development of content and narrative for the proposed exhibition brought about up-to-date, rigorous thought and enquiry, relevant to its subject matter, while the extensive use of action research techniques in the workshops, mainly through provocations rather than presentations, along with activities and events, also helped generate group discussions that teased-out numerous and insightful implications for the exhibition.

The workshop series also celebrated the 80<sup>th</sup> anniversary of the Science Museum's Noise Abatement Exhibition, instigated in 1935 by the Anti Noise League, who saw noise as a by-product of industrial modernity that needed to be tackled, not least by new silent technologies and measuring devices. The 1935 exhibition was used as a point of reference throughout the series especially during the second workshop at Nottingham University where it was placed in historical context.

From the outset, the approach in planning the three workshops for this research network was to avoid the 'shared report' style common in academic conferences and employ techniques from action research<sup>1</sup> aimed at producing a synthetic view through a 'shared enquiry'. Each invited speaker was encouraged to deliver a short 'provocation' rather than paper presentation, exploring questions in their chosen subject and thus giving a far greater emphasis and duration to the group discussion that followed. The use of action research approaches was intended to provoke novel interactions, enabling the participants not only to break down barriers between disciplines and practice, but also to set the terms for doing so between academics, researchers, music specialists and the public in a museum context.

Each workshop was held over a day and a half. The first session consisted of mutual

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<sup>1</sup> Burns, Danny, *Systemic Action Research: A Strategy for Whole System Change* (Policy Press, 2007) passim

introductions where every participant was asked to bring either an object, sound or thought related to the current workshop theme or to the general theme of Music, Noise and Silence and their interrelations. These preliminary sessions proved to be highly successful elements of the workshop series as participants were encouraged to think in terms of objects, sounds and music, each presented with a particular narrative, much like a museum curator might decide on artefacts for display. A collection of the contributions from all the three sessions could have formed an impressive and original exhibition on sound, science and technology on their own and some of these are described in the following chapters. The final afternoon session would consist of up to two provocations by invited speakers to inaugurate the workshop and set the terms for discussion on its theme.

First-day evenings consisted of specially programmed concerts and other events that were open to the public, including the premiere of a new sound installation, a film showing and a silent disco made in conjunction with university students. Workshop participants in the main, performed or created work especially for these evening events that provided additional stimulus for discussion during the following days. The second day of the workshops began with a group activity. In chronological order these were a visit to an anechoic chamber, a recording session and a hands-on electronic instrument-building workshop. As with the programme of evening events, these practical activities generated discussion among the participants. It was also suggested that the three aforementioned activities be somehow incorporated into a future Science Museum exhibition.

Provocations by invited speakers would follow each activity. In two cases, the provocation took the form of a performance presentation, mixing improvisation, text readings, sounds, music and noise. In the context of a colloquium on music and science that was much orientated towards sound studies, these experimental presentations probed relationships between language and experience. The concluding afternoon sessions consisted of presentations by high profile speakers that were open to the public.

The titular themes of music, noise and silence provided a conceptual and theoretical framework for the workshop series and the sequence of workshops may be seen as forming a crescendo from silence to noise: “Silence and Music” at the Royal College of Music (February 25<sup>th</sup> and 26<sup>th</sup>.) set out to look at how, in our post-industrial age, some new music genres have incorporated silence to such a significant degree that their works often comprise more notated silences than sounds. “Noise and Silence” at Nottingham University (26<sup>th</sup> and 27<sup>th</sup> March), explored the sonic cultural context of industrial modernity which made noise an issue before, during and after the interwar period, and which saw the Science Museum hosting in 1935 a significant exhibition on noise abatement. Finally, in the “Music and Noise” workshop at the Science Museum (23<sup>rd</sup> and 24<sup>th</sup> April), it was posited that if, categorically, the opposite of music is said to

be noise, then in what ways has the boundary between music and noise been negotiated?

### **Workshop One: Silence and Music, Dana Centre & Royal College of Music, London**

The first workshop, held in conjunction with the Royal College of Music, sought to be an examination of how, in our post-industrial age, some new music genres have incorporated silence to such a significant degree that their works often comprise more notated silences than sounds. The very first session though, which began with a group introduction and individual presentation of ideas, sounds and objects brought by the participants to illustrate the theme of the workshop, introduced a wider range of subjects into the discussion. Frode Weium showed an image of the *Testophone*,<sup>2</sup> an elaborate car horn device from the early 1900s that played melodies instead of honks and was proffered as a creative attempt to replace an invasive and alarming noise with something more musical. This object sparked a discussion about environmental noise, sound design in the car industry and the use of sound in mechanical fault diagnostics - topics that would be elaborated in more detail during the second workshop. Composer John Lely played a series of sounds, short bursts of noise interspersed with periods of silence. Presented as an auditory perceptual game, Lely's idea was use the silences as a time duration in which to anticipate the sounds that are about to happen, that the sounds themselves may be predicted or foretold by the listener. This demonstration was likened to experiments in auditory memory undertaken by psychologists in the late 1960s from which the term 'echoic memory' was first coined to describe the memory of sounds for short periods directly after hearing them. The period of time might only last for a few seconds, and as such, it was considered to be a type of sensory memory.<sup>3</sup>

Trevor Pinch recounted a study he once undertook as a sociologist that examined, through conversation analysis, the role of silence in the act of selling. A group of telephone salespersons were recorded whilst selling advertisement space for a newspaper and it was found that the most effective salespersons were those who used silence at crucial moments during the sales pitch. When the seller held back, prospective customers would instinctively start talking in order to avoid an awkward silence and, more often than not, found themselves accepting the deal on offer.<sup>4</sup>

Composer James Saunders provided a fittingly contentious talk entitled *Wandelweiser and the Contingency of Silence*, which also served as an introduction to some of the music played during an evening concert. Wandelweiser is a loose collective of around fifty composers from Germany, Austria, Switzerland Netherlands and the U.S.A., that emerged

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<sup>2</sup> Invented by the French inventor Etienne Teste, the *Testophone* was a multi-horn device designed for automobiles and capable of playing more than one melody. Several patents were published between 1910 - 1914. <https://digitaltmuseum.se/021026353664/signalhorn?aq=descname%3A%22Signalhorn%22&i=2> (accessed February 20th, 2017).

<sup>3</sup> Radvansky, Gabriel. *Human Memory* (Boston: Allyn and Bacon, 2005) p. 65–75

<sup>4</sup> Trevor Pinch's personal recollection of a study undertaken at York University c.1985, together with Colin Clark.

in the 1990s to form a record label, music publisher and website of the same name.<sup>5</sup> Their work is characterised by very long silences and very few sounds, although there is considerable variety within their scores, and this consideration of silence is at the heart of Wandelweiser composers' activities. Their radical stance is epitomised in the following statement by composer Manfred Frey:

"There is no reason for any specific duration of a work. There is no reason for any specific duration of a sound event. As there is no reason for any specific relation of duration between sound and silence, there will be conceptually equal duration of both."<sup>6</sup>

Wandelweiser's music has become increasingly prominent in experimental music circles over the past 15 years with leading figures from the group such as Michael Pisaro at CalArts<sup>7</sup> having an influence on younger composers in North America and Europe. Pisaro states:

"I believe there are three kinds of silence. At the deepest level hearing turns inward and the mind is silent. This absolute silence, is the result of careful persistent effort, and is rarely achieved. At the next level, there is the kind of silence described above; a silence which is the result of a gap the mind creates in the listening process, as it goes to work on the sound. On the surface level, what occurs between sounds is "silence" - not really a silence at all. "Silence" is an openness to any contingency, that is, to any sound. The singularity of the work flows into a multiplicity, first by unfolding the composite, and allowing the "supplementary detours" to fill up the surface. This surface then expands into an even wider multiplicity, in which the performers and audience join, by staying open to "silence."<sup>8</sup>

This dissection of silence in music is taken further by composer Jürg Frey who describes an "architecture of silence" where "space is opened which can only be opened with the disappearance of sound."<sup>9</sup> Shifting the balance towards silence in music then brings with it a "physicality of silence".<sup>10</sup> Their music also seeks to blur the divisions between performer and audience who both share the experience of listening during long periods of silence.<sup>11</sup> The music of the Wandelweiser group would seem to be a direct legacy of the music and ideas of John Cage and Morton Feldman, in particular the extremely long durations, very quiet, sparse and repetitive nature of Feldman's later works,<sup>12</sup> however,

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<sup>5</sup> <http://www.wandelweiser.de/>

<sup>6</sup> Saunders, James. *Testing the Consequences—Multipart Series in the Work of the Wandelweiser Composers*, Taylor & Francis Online, 17 May 2012 p 497-524  
<http://www.tandfonline.com/doi/full/10.1080/07494467.2011.676898>

<sup>7</sup> <https://directory.calarts.edu/node/1785>

<sup>8</sup> Text to accompany the composition *One Instrument with Four Foulds*, 1997  
<http://www.wandelweiser.de/michael-pisaro/texts.html>

<sup>9</sup> Jürg Frey, 1998, trans. M. Pisaro. <http://www.wandelweiser.de/juerg-frey/texts-e.html>

<sup>10</sup> Ibid.

<sup>11</sup> See Reynell, Simon. *Manfred Werder - Interview*, (2013) <http://manfred-werder-archives.blogspot.co.uk/>

<sup>12</sup> Two examples of Morton Feldman's lengthy late works are the *String Quartet II* (1983) and *For Philip Guston* (1984), lasting four and six hours respectively.

they were also a reaction and in direct opposition to the complex new music and free improvisation and jazz of the era from which they emerged.

The music and philosophy of the Wandelweiser group had a mixed response from the workshop participants. Although seeking intersubjectivity, Wandelweiser's music was thought, by George Revill, to create a shared experience only at a very formalist level, and the extreme quiet and stillness of Wandelweiser concerts was compared by Hillel Schwartz to early puritan gatherings where silence and attention among the congregation would be enforced by a church Deacon using a long "puritan stick".<sup>13</sup>

It was recognised though, that whilst it is tempting to think that quietude in new forms of contemporary music are simply a response to 'noisy modernity', they are, more often than not, created in polarity to current musical practices and norms and draw their inspiration from past musical influences, in Wandelweiser's case, from the 'New York School' of experimental music composition.<sup>14</sup>

The first day of the workshop concluded with an evening concert at the Holy Trinity Church in South Kensington. Curated by John Lely, the concert took the form of an hour-long continuous performance of works by four composers "who share an appreciation of silence, duration and listening."<sup>15</sup> The opening work by G. Douglas Barrett entitled *A Few Silence* (2008), consisted of a set of instructions for any number of performers who, during the first half of the piece and aided by pens, paper and stopwatches, were required to "listen to the "silence" of the performance space while creating written scores based on their observation of sounds that occur within this time-span."<sup>16</sup> The second half of the piece was the simultaneous interpretation of these individual transcriptions of sounds that occurred in the space, performed on a variety of instruments, objects and sound-making devices. As well as exploring the notion of transcribing sounds, Barrett's piece "brings the act of verbal notation into the realm of performance."<sup>17</sup> The remaining works were by members of the Wandelweiser collective and, in contrast, were predetermined, conventionally notated and predominately pitch-based scores; Jürg Frey's composition *Wen 3* (1999/2000) for solo violin, focused on major second intervals, interpolated with periods of silence, while Stefan Thut's *two (strings) and boxes* (2012/13), also made use of spatialisation as two large cardboard boxes were slowly pushed by the performers along the church aisles on either side of the audience. The boxes acted as resonators for two zithers placed on top and the movement allowed for the sounds to be played from differing angles in relation to the audience. The final piece, *Kiarostami Quintets* (2004) by Antoine Beuger, was performed by five musicians placed in opposite corners of the church who played part of a fifty-

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<sup>13</sup> The puritan stick (a.k.a. 'silence' or 'church stick' was typically a long staff with a round knob attached to one for knocking on young misbehavers and a feather on the other to awaken dozing adults.

<sup>14</sup> 'The New York School' that emerged in the 1950s and represented by the composers John Cage, Morton Feldman, Christian Wolff, David Tudor and Earl Brown. See Nyman, Michael. *Experimental Music: Cage and Beyond*. London: Studio Vista, 1974. p. 50

<sup>15</sup> John Lely in his programme notes for the concert. Feb. 2015.

<sup>16</sup> G. Douglas Barrett *A Few Silence* (2008), extract from verbal score.

<sup>17</sup> Lely, J., Saunders, J. *Word Events: Perspectives on Verbal Notation* (New York: Continuum, 2012), pp. 97-108.

page score. The material had been generated using chance procedures and the players were also given free rein to microtonally alter the given pitches, further augmenting the aleatoric nature of the piece.

In a concert where softly played sounds and silence were performed in equal measure, the silences were often impregnated by outside traffic noises, interrupting the quietude and reflection during these moments, but wholly apposite to the forthcoming discussions as the subject of environmental noise would be a recurring theme throughout the workshop series. Both the concert and Saunders' provocation that preceded it, made a clear case for music scores to be incorporated in the proposed exhibition, to illustrate how composers have conceptualised silence and noise through musical notation, including examples that consist of verbal instructions and graphics, as well as conventionally notated compositions.

The second day of the workshop began with a morning visit to London South Bank University's Acoustics Research Centre. Attendees were given a guided tour of both an anechoic and an adjoining resonance chamber in small groups led by Dr Luis Gomez-Agustina, Research Fellow at the Acoustics Research Centre. Each group was allowed several minutes to become adjusted to the silent environment within the anechoic chamber, and it was during one of these tours that John Kannenberg made a field recording of four minutes and thirty three seconds in length of the 'sound' within the chamber – a reference to John Cage's famous silent composition 4'33", as well as Cage's oft-recounted story of his own visit to an anechoic chamber which led him to declare there was 'no such thing as silence'.<sup>18</sup> This recording would later be played back for the workshop attendees at the Royal College of Music, where it was accompanied by the sounds of musicians practising in the neighbouring rooms.<sup>19</sup>

With a small library of books, compact discs, and photocopied texts spread across the floor and a pair of laptop computers on the table behind them, Daniela Cascella and Salomé Voegelin began the first of the day's three provocations with an improvised performance of spoken texts and pre-recorded sounds that did less to speak about the absence of sound than to explore various types of silencing - of preventing someone or something from sounding. Incorporating texts by authors including Daniil Kharmis, Brandon LaBelle, Frances Dyson, and Samuel Beckett along with sounds from films such as Billy Wilder's *Sunset Boulevard* and Werner Herzog's *Grizzly Man*, the pair spoke to silence as an action as well as a condition, most viscerally when Voegelin increased the volume of one of the playback sounds to drown out the sound of Cascella's recitation.

Silence cloths – pads used underneath tablecloths to dampen the sound of tableware – are one type of object that can represent silence in an ordinary way, according to David

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<sup>18</sup> Gann, Kyle. 2010. *No Such Thing As Silence (Icons of America Series)* (London: Yale University Press, 2010). Cage tells the story Nam June Paik's video *Global Groove* (1973), see: <https://www.youtube.com/watch?v=jS9ZOIFB-kI> (accessed on 20.07.2017).

<sup>19</sup> Kannenberg, John. 4'33" in an Anechoic Chamber (Audio file, 2015) <https://soundcloud.com/johnkannenberg/4-33-in-an-anechoic-chamber>

Toop. His provocation began with a discussion of etiquette, moving onto the notion that dirt is just matter in the wrong place<sup>20</sup> before positing that perhaps noise is just sound in the wrong place. Via a mixture of readings, storytelling, and pre-recorded sound, Toop wove together concepts of “silenced” objects – items no longer in use such as blotting paper – with ancient ceremonies, such as a water ceremony in Nara, Japan that has been going on for over a thousand years wherein water is collected each year and added to a bucket containing water gathered every year previously. He played some excerpts of what he referred to as “historical silences”: experimental music performances containing precise moments of musical restraint shared amongst improvising musicians dating back to the 1970s. And yet with examples of silences from around the world and throughout history, Toop insisted that silence is an impossibility due to the existence of consciousness – one’s mind is always engaged with something, he argued, something we always “hear” inside our heads, which makes even the alleged silence within an anechoic chamber an impossibility. To end his provocation, Toop presented a set of bells he acquired on a trip to Laos; several days later during his trip, he arrived at a Hmong village where the women and children were forced to perform the degrading task of selling useless trinkets to tourists while the men of the village sat inside a house, using the very same bells in a ceremony. For Toop, this was an overwhelmingly sad, extremely powerful experience of silencing.

During the discussion following Toop’s presentation, he expounded upon this experience; it made him aware, he said, of what silence really is - a situation far too complicated to ever be resolved ethically. Salomé Voegelin suggested that, on this view, there must be a gender issue implicit within silence, to which Toop agreed; they also concurred that silence generally seems to be conceived as an idealised spiritual state that only men are allowed to reach. This led to a question about the idea of perfection having to be redefined in the era of mass production, with Toop noting that men often appoint themselves as the custodians of perfection within culture. The urge for the definition of noise and silence is what is possibly gendered rather than noise and silence themselves, Voegelin suggested, and Toop added that the urge for classification is also often gendered as well. The discussion ended with Toop’s suggestion that the language surrounding silence has not quite developed yet, with very few English words existing that mean different kinds of silences; visual words like “selfie” enter the lexicon quite easily while sound-related terms like Christopher Small’s “musicking” doesn’t.<sup>21</sup>

The noise of almost nothing – sounds that are barely perceptible by the human ear and consequently devoid of the necessary meaning that humans require in order for sound to be properly processed without causing discomfort or insanity – are intimately connected with humanity’s shifting relationship with the environment, according to Hillel Schwartz who gave the final provocation of the workshop. Entitled *In Audibility: A provocation concerning phenomena that wobble at the elusive, possibly illusive,*

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<sup>20</sup> Douglas, Mary (ed.). *Rules and Meanings* (London: Penguin Books, 1973)

<sup>21</sup> Small, Christopher. *Musicking: The Meanings of Performing and Listening* (Middletown, CT: Wesleyan University Press, 1998)

*intersection of music, silence, and noise.* Using Joseph Wright of Derby's painting 'An Experiment on a Bird in the Air Pump,' (1768)<sup>22</sup> as a starting point, Schwartz went on to discuss the barely audible noises of terror: the ellipses, commas, and dashes of Gothic novelists; the spirit voices allegedly discovered on unrecorded magnetic tape in 'Electronic Voice Phenomena'<sup>23</sup>; the quest to listen to the voices of single-celled organisms via sonocytology. Humans are keyed by anxiety to be more disturbed by what is just noticeable rather than what is blatant, according to Schwartz, and it is this trait that leads to a mixed sense of liveliness and loss when confronted by the noise of almost nothing.

During the questioning, the idea of what painters want the viewer to hear in their paintings was discussed, with concern that the Wright painting may be about conversations rather than the muffled silencing of the bird in the bell jar. There was some concern about what the appeal of the Wright painting still is, since not only is the original hanging in the National gallery but copies of it are hung in other museums in Europe – the best answer seemed to be that it tells a compelling story, which is what curators are usually after when choosing objects to exhibit. And while it was agreed the content of this painting is far from politically correct in our current culture, Tim Boon suggested that its inclusion in a contemporary museum display might be seen as throwing a bit of “dirt” into the mix, in reference to the earlier discussion of the definition of dirt/noise during the discussion following David Toop's provocation. That word – “provocation” – was then suggested by Schwartz to somehow be incorporated into the upcoming Science Museum exhibition, since its etymology translates into “to call forth”, an activity Schwartz posited might be resonant with the sounding process of an audience engaging with museum objects related to sound.

The second day of the workshop focused much more on generalised and musical forms of silence and music, with the presentation of Hillel Schwarz being the only one that engaged directly with the idea of sound in a museum context. Perhaps inevitably for an event that took place mostly at the Royal College of Music, musicality dominated the discussion and presentation of sound rather than a higher-level categorisation of sound in general with music as merely one of its components. With music the obvious gateway into the world of experimental sound, this workshop acted as an opening through which the world of sound could begin to be engaged by the participants, acclimatising the guests to the idea of thinking sonically rather than thinking from a purely museological perspective. As one participant suggested, the workshop brought to attention the environmental sounds surrounding things which can't be shown – a curatorial conundrum that would become a more dominant theme as the workshop series continued.

## **Workshop Two: Noise & Silence, University of Nottingham**

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<sup>22</sup> Exhibited in the National Gallery, London.

<sup>23</sup> EVP is a branch of parapsychology begun in 1959 by Friedrich Jurgenson. (needs citation)



The second workshop, held in conjunction with the University of Nottingham's [Sensory Studies Network](#) and hosted by [Nottingham Lakeside Arts](#), set out to investigate the second pairing of auditory categories: noise and silence. Here, the aim was to explore the broader, 'non-musical', sound worlds of everyday life in which music exists. Specifically, the workshop set out to examine the sonic cultural context of industrial modernity which made noise an issue before, during and after the interwar period, and which saw the Science Museum host a major noise abatement exhibition in 1935. The exhibition was organised by the Anti-Noise League, a national body founded in 1934 to promote the suppression of 'needless noise'. Its leaders promoted 'quiet' as the desirable compromise between noise and silence; the ideal sonic register of a civilized society. The League did not wish to turn back the clock on modern progress, but equally thought that new technological developments such as the motorcar and the wireless loudspeaker would lead to unbearable sonic chaos in the future. Modern urban and industrial noise was cast in this context as unnatural and unhealthy, often in contrast to the natural and healthy qualities of rural sounds and the right kinds of music. Although they probably appeared more urgent in the early years of automobile travel and personal music reproduction technology, questions of healthy and unhealthy sound, of divisions between private and public sonic spaces, and of how these issues should be managed through expert intervention are very much still with us today. In Britain, the Anti-Noise League's mantle was taken up in the post-war period by the still very much active . In the modern age of industry and urbanisation, listening attention broadened to include the everyday, apparently meaningless sounds of social hubbub. The struggle to give meaning to these ambient sounds, of how to hear and control them, has formed a significant part of our modern auditory culture, shaping in turn the way we hear and think about music, silence and all kinds of sounds in between.

In order to map out this set of issues, and to think through ways of presenting them in a future Science Museum exhibition, we invited a broad range of academics and practitioners to present provocations in the form of talks and sonic interventions on the theme of noise and silence. As a backdrop to the two days of activities, the first thing we did was to install our own version of the 1935 Science Museum noise abatement exhibition in the foyer of Lakeside's concert hall as a prompt to further discussion. We included a series of photos of the original exhibition as well as a selection of the articles and adverts that appeared in the accompanying pamphlet given to visitors in 1935. Several of the talks over the two workshop days used the 1935 exhibition as their starting point, drawing on the materials we displayed. Karin Bijsterveld pointed out in her talk on the first day of the workshop that the 1935 exhibition, along with the wider logic of noise abatement at the time, looked primarily to material solutions to the problem of unwanted sound: that is, to measures which could quieten or silence technology through engineering solutions relating either to the technological object itself or to the transmission of sound from that object. Indeed, the 1935 exhibition as more or less a trade show of new technologies whose aim was to silence, to measure, or to control everyday sound at source. Silence was a significant theme and ideal in the presentation of the exhibits, from the promised 'Silent Railcar' depicted in the transport section of the exhibition (top right of Figure X), to the 'Silent Lift' also on display, and the

advertises for various silent consumer technologies, including the 'Silenta Typewriter' for harmony in the workplace and the 'extraordinarily quiet' Electrolux vacuum cleaner aimed at housewife exhibition-goers (Figure X). Silence took on futuristic qualities in the 1935 exhibition. It was framed as an ultimate aim of design sophistication.



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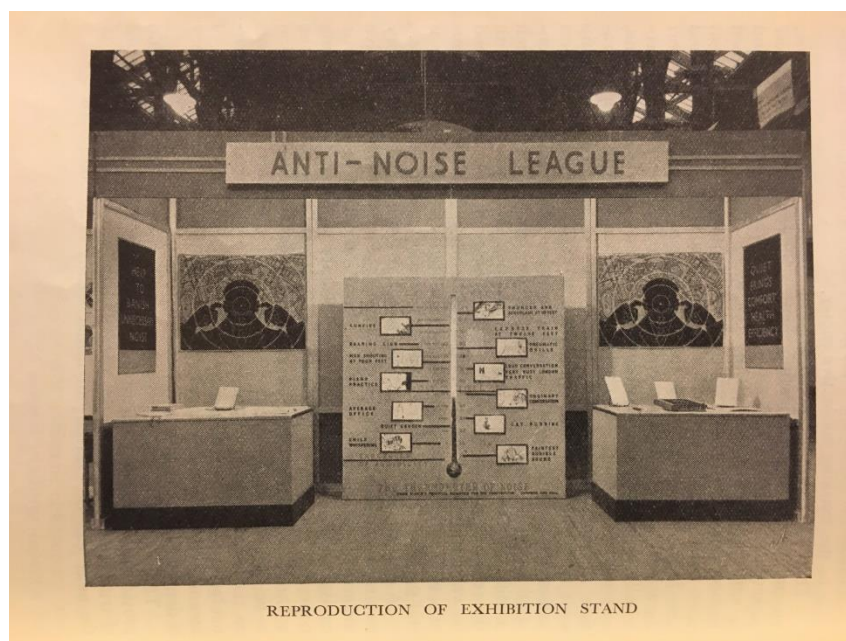
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If engineering and technological innovation was presented as the solution to the problem of noise in 1935, there remained nevertheless a need to give shape to the problem itself. This was achieved primarily through medical arguments about the health effects of noise, as seen in Figure X, a photo of the stand used by the Anti-Noise League for health exhibitions, which depicted the health effects of noise on a mock thermometer and included posters with taglines such as 'Quiet Brings Comfort, Health and Efficiency'. Attempting to shift anti-noise discourse away from an association with the exceptional 'neurasthenic' sufferer, the Anti-Noise League claimed that noise was a genuine public health hazard, diminishing the efficiency and 'nervous' wellbeing of *all* hearers, not only those pre-disposed to hyper-sensitivity.<sup>24</sup> Despite the fact that the 1935 exhibition was held with the active collaboration of government ministers and civil servants, James Mansell argued in his talk on the second day of the workshop that the Anti-Noise League never fully succeeded in convincing government authorities of the health dangers of noise (see: <http://journal.sciencemuseum.ac.uk/browse/issue-07/chamber-of-noise-horrors/>). His archive research, recently published as *Hearing Modernity: The 'Age of Noise' in Britain*, shows that the League's insistence that modern noise caused physical,

<sup>24</sup> Lord Horder, 'The Elimination of Needless Noise,' in xxxx

vibratory, disturbance to the body's nervous system was rejected by government scientists gathered at state agencies such as the Industrial Health Research Board, who on the whole drew upon newer, psychological, theories which pointed to the conclusion that noise sensitivity results from pre-existing disorders of the mind rather than physiological disturbance to the body.<sup>25</sup> Bijsterveld described this in her talk as part of an 'individualisation' of responsibility for the problem of noise from the 1930s to the present day. Rather than a social question, noise became a matter of the unpredictable mental variation between human beings, and, indeed, as, Mansell argued, a matter of the individual's willingness to adapt to modernity and maintain mental resilience in the face of a constantly changing world.<sup>26</sup> Mansell pointed to a 'politics of knowledge' in the 1930s where noise was concerned: different expert groups (doctors, engineers, psychologists) were competing to act as expert listeners at this time. That the psychological argument ultimately won out over the physiological one in the 1930s reveals a good deal not only about the ebb and flow of expert discourse but also about our lasting culture of dealing with noise. In one way or another, noise has remained politically and scientifically difficult to pin down and a fascinating index of our cultural relationship with sound.



Three talks used the 1935 exhibition as a prompt to talk about the longer history of noise sciences up to the present day, and about how we might overcome some long-lasting problems in our relationship with unwanted sound and public soundscapes more generally. Bijsterveld noted that many of the approaches to noise begun in the 1930s have continued, including the problematic 'individualisation' of responsibility for noise, especially in relation to the slippery issue of domestic noise, where individuals are often

<sup>25</sup> James G. Mansell, *Hearing Modernity: The 'Age of Noise' in Britain* (Urbana, IL: University of Illinois Press, 2016).

<sup>26</sup> These arguments were based in part on Karin Bijsterveld, *Mechanical Sound: Technology, Culture and Public Problems of Noise in the Twentieth Century* (Cambridge, MA: MIT Press, 2008).



left to their own devices to solve disputes with neighbours. With no sustained attention dedicated by public authorities to the question of sonic community, Bijsterveld suggested that we might find new ways to think about neighbour noise not in the work of engineers or public health officials, but rather in what she described as ‘the sonic skills of artists’. She introduced a number of recent arts projects to demonstrate the kinds of interventions that might lead the way in finding social solutions to building shared sonic spaces in our domestic lives. For example, in one Dutch neighbourhood the local authority employed a composer and a theatre director to come up with a performance integrating the sound of a leaf blower with traditional musical instruments in order to encourage close critical listening to the everyday sonic environment. The idea was that by being caused to listen to a leaf blower out of the usual context of everyday life, community members might come to reflect both on their own use of potentially disturbing sound-emitting machines and on why mechanical sounds, such as that of the leaf blower, are heard as annoying in the first place. Bijsterveld argued that artists are perhaps better placed to offer us alternative ways of thinking about sonic space, for example in artist Sarah von Sonsbeeck’s projects ‘Letter to my Neighbours’ and ‘Machine for my Neighbours’, which draw attention to the sonic spaces we share by, humorously, in the first case, demanding rent on the space taken up in her apartment by intruding neighbour sounds. Noise is a human, social, problem, and might be better approached not exclusively through scientific-technical rationalisation, but rather, also, through cultural dialogue and community building; a process of coming together to establish shared consciousness of sound. That is an aim which might well be taken up in a future exhibition on sound.

Town planning consultant Max Dixon, author of London’s [‘Sunder City’](#) plan, the UK’s first citywide strategy for managing environmental noise, reminded us that, nevertheless, state-funded action on noise is still justified and financed not primarily on cultural grounds, but rather on medical ones.<sup>27</sup> Dixon pointed to the most recent studies on the health effects of noise, which attempt to make a case for a causal link between noise and raised blood pressure and cardiovascular disease. He called for ‘sustainable soundscape co-creation’ rather than noise abatement, pointing to the need for industry, government and citizens to work together to create more liveable sound environments. However, he expressed doubt about arts interventions which encourage a *too* close listening attention to the everyday sound world, because, in his experience, we depend upon our ability to adapt to environmental sound by learning to ignore it, or at least not listening to it in detail. As evidence for this, he pointed to the Darlington Quiet Town experiment of the 1970s, during which the population of a single town were targeted with a noise awareness campaign and with significant reductions of environmental noise achieved via traffic re-routing, after which people became in fact *more* likely to complain about disturbing sounds, despite a measurable reduction in noise levels, because they had been newly sensitised to their sonic environment. Dixon also reminded us that the science and technology of noise has moved on significantly since the 1930s, even if some of our cultural narratives of it have not, and he insisted that any

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<sup>27</sup> *Sunder City: The Mayor’s Ambient Noise Strategy* (London: Greater London Authority, 2004).

future exhibition should take account of the current state of the field, and point the way to possible future developments, such as the evolution of 'intelligent ear lids' which might allow us to filter the sounds that reach us.

John Levack Drever, a sonic ecologist and sound artist, made an important intervention by insisting that when thinking about noise and sonic product design, we still place too much emphasis on sounds themselves, and not on how we hear them. Indeed, Drever is sceptical about a singular category of 'hearing', since, as he pointed out, we all hear differently thanks to the ways in which our hearing apparatus deteriorates as we age and thanks also to a whole plethora of conditions, such as hyperacusis (intensified sensitivity to certain frequencies of sound) which afflict a significant number of people, but which are not usually taken account of in the acoustics of product design. His provocation was that we should move away from a normative 'auraltypical' theory of audition, to a model of aural diversity in which we take account of our multiplicity of hearing modes. He pointed out that hearing also varies culturally, offering the example of Japan, where some women are hyper-aware of sounds made in public toilets, and carry personal sound-emitting gadgets for the purposes of sonic modesty. Such devices might make interesting exhibits, as would artefacts from the history of hearing aid development, pointing as they would to the significant differences in our hearing abilities and to the need to take account of our diversity of hearing experiences.

On the second day of the workshop, anthropologist of hospital soundscapes Tom Rice returned to the question of the medical arguments made against noise.<sup>28</sup> As Mansell had earlier pointed out, in the 1930s there had been no consensus about exactly how noise impacts upon health, and the issue had been caught up in a wider conflict between physical and psychological medicine, particularly in the field of industrial health. Rice argued that in many ways little has changed up to the present day: although a good deal of medical research has been done on noise's impact on sleep, blood pressure, and cardiovascular health, among other things, the science remains uncertain and contested. And yet, as Rice pointed out, the *longue durée* of the noise-as-problem discourse shows us the extent to which anti-noise claims depend upon medical underpinnings. Rice reminded us that Florence Nightingale was the first to promote quiet conditions in hospital wards and pioneered the use of quiet slippers for nurses. He argued that throughout the modern history of noise abatement, appeals to the need for quiet for convalescence, and more widely the argument that noise is a cause, or at least a prolonging factor, in illness, has been a major, if not *the* major theme in the noise abatement campaigns of industrialised nations. This raises interesting questions about the role of medicine and health as master discourses and about the cross-over between cultural anxiety and medicalised anxiety. Rice offered the example of a northern Thai community where a condition of tiredness and raised anxiety is officially linked to noise, but specifically to types of noise which are associated with the encroachment of outside culture, such as the sound of new technologies like the motorbike.

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<sup>28</sup> He drew upon his book *Hearing and the Hospital: Sound, Listening, Knowledge and Experience* (Canon Pyon: Sean Kingston Publishing, 2013).

Cultural historian Shelley Trower prompted us to think beyond audible noise to the category of vibration, often discussed in connection to noise, but sensed, she argued, beyond its audible registers.<sup>29</sup> Turning to Victorian literature and medical writings, Trower argued that the cultural relationship with modern machines was encapsulated in discussions of vibration and vibratory affect, sometimes audible, but with effects beyond the sonic. Railway travel is a good example, she said, of a new technology which prompted anxiety about unseen, sometimes unfelt forces forging unnatural bonds between machine and body, causing the latter to resonate in damaging ways. Noise was part of this discussion, but tied up with it was an intense anxiety about unheard and unseen forces in the Victorian period. Trower argued that, as with noise, scientists set themselves the task of knowing and controlling these unseen forces, going to elaborate lengths to depict them in visual form. Such visualisation, including later developments in noise meter technology, could certainly provide a very interesting dimension to an exhibition on sound. Trower's point about unheard vibrations also points to a wider body of literature in sound studies on the importance of thinking about sound's physical effects and the political implications of these – what Steve Goodman refers to in his study of sonic warfare as the 'politics of frequency' – as well as work on the cultural and artistic life of vibration, particularly in modernism.<sup>30</sup>

The final talk of the workshop was delivered by media historian David Hendy, presenter of the BBC Radio 4 series ['Noise: A Human History'](#).<sup>31</sup> Drawing on research conducted for that series, Hendy turned our attention away from science, knowledge and policy and towards questions of social politics. Hendy argued that noise is best defined not universally as sound out of place, but instead as sound that a particular kind of person, in a particular kind of place, designates as unwanted in their specific cultural context. Hendy insisted that such designations always tell us something about power, whether of the wealthy over the less wealthy, or of men over women, or of older generations over younger ones. Turning to alternative sources for insight into noise such as court records, diaries and social observation, Hendy argued for an approach blending both macro and micro approaches to the analysis of noise's entanglement with power. The macro approach is necessary because, as Hendy reminded us, noise is often shifted to places in the world where it is out of earshot of those who can afford to live in quietness. These shifts, in the age of globalised economy, are often also global in scale. Hendy insisted that one person's quiet is almost always bought at the expense of someone else's noise, and that global inequalities in access to quiet often remain distinctly under the radar in cultural terms. When we settle down to quietly read a book, for example, we should remember that others have endured the sound of the logging, pulping and haulage distribution of the artefact in our hands. On the microscale, Hendy argued that we should be attentive, too, to the ways in which economic and social inequalities are

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<sup>29</sup> Trower was drawing on her book *Senses of Vibration: A History of the Pleasure and Pain of Sound* (New York: Continuum, 2012).

<sup>30</sup> Steve Goodman, *Sonic Warfare: Sound, Affect and the Ecology of Fear* (Cambridge, MA: MIT Press, 2010), p.xv; Anthony Enns and Shelley Trower (eds.), *Vibratory Modernism* (Basingstoke: Palgrave Macmillan, 2013).

<sup>31</sup> The programme is also available as a book: David Hendy, *Noise: A Human History of Sound and Listening* (

played out in intimate everyday lives. The micro-political experiences of daily noise imposed on those who must live and work in earshot of unceasing din barely register in the consciousness of those who are lucky enough to have access to quiet, but are nevertheless part of the way in which inequality is sensed and felt. Hendy's call to search out these experiences in court records, diaries and in other forms of less obviously sound-related source material could certainly provide a way of accounting for the socio-political dimensions of noise in an exhibition.

In addition to talks and discussion, the workshop featured practical interventions intended to stimulate debate about how to engage museum goers in an exhibition about sound. A new sound art commission by , a sound art group consisting of architects Paul Bavister and Jason Flanagan, and acoustician Ian Knowles, was the major feature in this respect. Audialsense specialise in installation works which reveal the acoustic properties of particular architectural spaces. Having worked in the turbine hall of Tate Modern, where they played a 100 hertz sine wave of the space's resonant frequency back into the space to reveal surprising spatialized sonic phenomena, Audialsense created a new installation entitled 'Walk' especially for the Trent Tunnel at the University of Nottingham, a long, curving, 90 metre, underground walkway connecting two of the major buildings on campus, the Trent Building and the Portland Building. The tunnel has peculiar acoustic properties, including the noticeable reverberation of footsteps. 'Walk' was a four-channel audio work consisting of a base sine wave of 70 hertz along with a combination of other pure tones based on a Japanese scale, along with the sound of ghostly footsteps accompanying the visitor as they moved through the tunnel. Movement of the listener was the key to experiencing the work, as Paul Bavister explained in his introduction. Only by moving through the tunnel, experiencing the unique qualities of this acoustic space, would the combination of tones merge to form a constantly shifting, echoing, whole [Embed Soundcloud here](#). Audialsense encourage us to *feel* buildings differently by taking account, artistically, of acoustic phenomena which normally remain unnoticed. 'Walk' was installed for two full days of normal university life and transformed the tunnel from a humdrum zone of transit to a remarkable place of dwelling. Travellers slowed their pace as they moved through the sonic tunnel, becoming more aware of the sound of their own footsteps, stopping to look up and around, and to wonder about the sounds around them. Bijsterveld's point about the sonic skills of artists is thus an important one: artists can enliven our sense of hearing, causing us to experience place and sound differently.

The second day of the workshop included a practical activity led by Aleks Kolkowski and composer/conductor Jean-Philippe Calvin. The participants took part in an analogue recording session that reenacted an early sound effects recording from 1929 of crowd noises, direct-to-78rpm disc using a vintage recording lathe. An original 78rpm shellac disc record of crowd noises was played to the group who then rehearsed in order to



recreate a version of it.<sup>32</sup> The resultant hubbub, which crescendoed to an uproar, is typical in crowd recordings of the period which were all made and orchestrated in the studio by groups of actors or extras under strict direction.<sup>33</sup> A video documenting the making-of process as well as the final 78rpm disc recording can be viewed online.<sup>34</sup>

### **Embed video from Vimeo:**

The recording activity provoked discussion around the nature and use of recorded sound effects in theatre, film and radio, and of hyperreality in sound production, where natural sounds have been greatly exaggerated or replaced with artificially produced sounds in order to enhance the medium they serve.<sup>35</sup> The first known use of a recorded sound effect in the theatre took place in 1890, where a wax cylinder recording of a baby crying was reproduced via an off-stage phonograph.<sup>36</sup> Studio-made sound effects recordings were published throughout the acoustic and electrical eras and continue to be made today. However, it was only until magnetic wire recorders became widely available during the mid-1940s, along with tape recorders during the 1950s, that recording sound effects live on location or “in the field” became more common. Workshop participants remarked on the phenomenon of commercial sound effects libraries, with sounds recorded in previous decades being reused in cinema and radio, even to the present day.<sup>37</sup> It was commented that the global commodification of sound has resulted in the widespread use of common tropes in the soundtracks of entertainment media that are easily recognisable to the trained ear and are often a source of irritation.

In a discussion on the soundtracks of cartoons, it was suggested that an animated film might feature in the proposed exhibition, where visitors are invited to choose between natural or artificial, ‘hyperrealistic’ sounds to accompany the images. Cartoons have also inspired researchers and technologists to develop new approaches in sound design and sound modeling, for example at IRCAM.<sup>38</sup> In the process of ‘cartoonification’, a sound

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<sup>32</sup> Volksauflauf (Vorbeiziehende Volksmenge, Aufruhr) Theater-Geräusch-Platter, (Parlophone (Lindström) Berlin, Matrix. No.: 37825, 1929). Translation: Crowd (passing crowd, uproar), Theatre-Sound Record.

<sup>33</sup> The process of making Crowd noises for theatre is described in Napier, Frank. *Noises Off; a Handbook of Sound Effects*, (London, F. Muller, Ltd., 1936) p. 94

<sup>34</sup> <https://vimeo.com/123489997> (Accessed on 5.6.2017).

<sup>35</sup> For a critical account of hyperreality in film sound, see: Whittington, W. “The Sonic Playpen: Sound Design and Technology in Pixar’s Animated Shorts” *The Oxford Book of Sound Studies* ed. by Trevor Pinch and Karin Bijsterveld (Oxford Handbooks, 2011) pp. 367-386

<sup>36</sup> Curtin, Adrian., *Avant-Garde Theatre Sound; Staging Sonic Modernity*, (Basingstoke: Palgrave Macmillan, 2014) p. 63

<sup>37</sup> Perhaps the most famous and enduring example of the reuse of sound effects is the “Wilhelm Scream”, first used in Raoul Walsh’s 1951 film *Distant Drums*, and since featured in numerous well-known titles. It is, allegedly, still being used today. See: *Does That Scream Sound Familiar?* ABC News Report, USA: 04.10.2007 <http://abcnews.go.com/WN/story?id=3728693&page=1> (Accessed on 5.6.2017). For a compilation of clips from films that have used the Wilhelm Scream see: <https://www.youtube.com/watch?v=cdbYsoEasio> (Accessed on 5.6.2017).

<sup>38</sup> IRCAM (*Institut de Recherche et Coordination Acoustique/Musique*), Paris. <https://www.ircam.fr/>

may be reduced to its essential elements and used as a template for creating a new and completely artificial sound, but with the same variations in dynamics and other factors as in the original.<sup>39</sup>

The recording activity also introduced an alternative thread to the workshop theme, namely the noise of the crowd. Rather than thinking of noise solely as it was defined in the 1935 Noise Abatement Exhibition, where the noise of industrial modernity is generated by machines and by people using those machines, the human noise of the crowd too is important to the experience of modernity, being constituent to the all-consuming modern metropolis with its masses of inhabitants. King Vidor's classic and appositely named film "The Crowd" (1928), ironically a silent film, was offered as an example through its cinematic, purely visual representation of urban noise and its destructiveness. This highly influential film has been linked to the anti-noise movements of the early 20<sup>th</sup> century in North America.<sup>40</sup> Silent film was of great interest to Antonin Artaud, a key figure in 20<sup>th</sup> century European avant-garde theatre who came up in discussion. Artaud's interest in the silent film lay in its silencing of, or liberation from, speech and the possible replacement of speech with noise when applied in the theatre.<sup>41</sup> His production of Shelly's *The Cenci* in 1935, was notable in this respect because of its novel use of sound effects, including recordings of bells and factory sounds reproduced from the four corners of the theatre, and also the use of the Ondes Martenot, an early electronic instrument.<sup>42</sup>

Another electronic instrument that came forth from the discussions around sound effects, and one suggested as an object for the proposed exhibition was the Mellotron, a keyboard instrument and early type of sampler that can play pre-recorded sounds of orchestral instruments, known mainly for its use by pop and rock bands from the late 1960s and into the 90's. The BBC acquired a Mellotron in 1964 exclusively for reproducing sound effects, its seventy-seven note, three-track tape system allowed it function as a large sample bank of sounds.<sup>43</sup> The BBC model now resides in the Science Museum Collection.<sup>44</sup>

It is clear that there would be no shortage of compelling artefacts relating to noise and silence to include in an exhibition. Some of the objects from the Science Museum's 1935 noise abatement exhibition, such as noise meters, are still in the museum's collection; promotional materials made by the Anti-Noise League still exist, and perhaps materials

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(Accessed on 5.6.2017).

<sup>39</sup> The process of 'cartoonification' is described in: Rocchesso, D. & Fontana, F. (ed.) *The Sounding Object* (Edizioni di Mondo Estremo, 2003)

<sup>40</sup> See HANLON, DENNIS. "The Roar of 'The Crowd': Urban Noise and Anti-Noise in Silent Cinema." *Mosaic: An Interdisciplinary Critical Journal*, vol. 42, no. 2, 2009, pp. 73–88.

<sup>41</sup> Scheer, E. (ed) *Antonin Artaud: A Critical Reader* (London: Routledge, 2004) p. 161

<sup>42</sup> Costich, J. *Antonin Artaud* (Twayne Publishers, 1979) p. 53

<sup>43</sup> See Niebur, L. *Special Sound: The Creation and Legacy of the BBC Radiophonic Workshop* (Oxford University Press, 2010) p. 125

<sup>44</sup> <http://collection.sciencemuseum.org.uk/objects/co6047/mellotron-keyboard-musical-instruments> (Accessed on 5.6.2017).

relating to the Darlington Quiet Town experiment mentioned by Max Dixon could be located in an archive too. Artworks such as those mentioned by Karin Bijsterveld would contrast interestingly with scientific objects, and Audialsense's approach to changing our listening attention could be effectively deployed in museum space as part of or alongside an exhibition. Crucially, in seeking to take account of the sonic categories of noise and silence, any exhibition would have to account for the essentially contested and political nature of the struggle to define *quiet*: who decides what constitutes that ideal compromise between noise and silence; who gains and loses access to it; how is it promoted and measured by scientists and policymakers? These questions cut to the core of what it is to live together in modern societies.

### **Workshop 3: Music & Noise, Science Museum, London**

The final workshop in the series saw a total of thirty-six participants from eleven countries come together at the Science Museum, London, to discuss relationships between music and noise. The workshop's first session took place at Blythe House, the Museum's storage facility in West London. The location allowed for sound-related artefacts from the Museum's collections to be readily accessible and in view, so as to stimulate discussion about material culture, science, sound and museum display with the proposed exhibition firmly in focus. To begin the workshop, a guided tour of the Sound Recording and Reproduction and the Acoustics collections was led by John Liffen, curator of Communications and Acoustics. Liffen assembled a selection of artefacts from the Acoustics Collection for the afternoon's provocation by the historian of science Myles Jackson, author of *Harmonious Triads: Physicists, Musicians, and Instrument Makers in Nineteenth-Century Germany* (2006), on the relationship between musical instruments and scientific instruments. It is likely that a number of these artefacts would be included in the proposed exhibition.

Jackson invited us to think about the history of late 18<sup>th</sup> and 19<sup>th</sup> century acoustics through the selection of objects laid out before him. Just as the workshop's aim was to problematise the boundary between music and noise, Jackson's talk problematised the boundary between scientific and musical instruments, as there are times where the instruments are both. Musical instruments provided experimental natural philosophers, physicists and physiologists with a rich choice of natural phenomenon needing explanation, such as combination tones, beats, resonance, vibrations and wave patterns. A case in point is the piano, notably used by leading scientific figures such as Thomas Young and Hermann Helmholtz, to research tuning systems and combination tones. During the nineteenth and well into the twentieth centuries, physicists, physiologists & neurophysiologists were also in dialogue with music teachers particularly of the piano, to study the mechanics of piano touch so that it may be taught to students.<sup>45</sup> This bio-mechanical research is also linked to the 'scientific management' of Frederick Taylor, who in the early 1900s promoted industrial efficiency through economy of movement

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<sup>45</sup> Kursell, Julia. "Piano Mécanique and Piano Biologique: Nikolai Bernstein's Neurophysiological Study of Piano Touch", *Configurations* 14, no. 3 (2006), pp. 245-73

and gesture and the physiology of labour.<sup>46</sup>

The origins of these scientific investigations into sound and music lie in the work of Ernst Chladni, who is seen as the founder of experimental acoustics. His 'Chladni Figures' or patterns formed by grains of sand on a metal plate that is made to resonate with a bow, are among the earliest visualisations of sound. They led him to study the vibrations of rigid surfaces and he used this research in the design of two new musical instruments, the 'euphon' (1791), based on the glass armonica of Benjamin Franklin - an example of which resides in the Museum's collection - and the 'clavicylinder' (1799).<sup>47</sup> Chladni's work on resonance influenced the design of conventional musical instruments too; the French physicist Félix Savart, best known in the study of acoustics for his 'Savart wheel', used Chladni figures to determine the optimum position of the sound post in violins. Another figure greatly influenced by Chladni is Charles Wheatstone, the English physicist, inventor and musical instrument-maker. Wheatstone's important contribution to the development of electrical telegraphy is deeply rooted in his earlier investigations as an experimental natural philosopher working with sound. His 'Enchanted lyre' or 'acoucryptophone' (1821, also part of the Museum's collection, currently on display at the Horniman Museum), publicly exhibited in London, featured a lyre-shaped soundbox hung from the ceiling that appeared to play autonomously, the sounds being transmitted by a wire connected to the soundboard of a piano and other instruments played in the room directly above. Wheatstone, reflecting on his system of sound propagation, wrote:

"could any conductive substance be rendered perfectly equal in density and elasticity, so as to allow the undulations to proceed with a uniform velocity without any reflections and interferences, it would be as easy to transmit sounds through such conductors from Aberdeen to London as it now is to establish a communication from one chamber to another. Whether any substance can be rendered thus homogenous and uniform, remains for future philosophers to determine." <sup>48</sup>

A non-musical but nevertheless popular scientific instrument, invented and exhibited by Wheatstone, was the kaleidophone (1827), a device that translated the sound vibrations of bowed or struck metal rods into optical patterns onto a surface, by shining light on reflective balls attached to their ends.<sup>49</sup>

Jackson proposed that by far the most important object in the late 18<sup>th</sup> and the 19<sup>th</sup> century in the study of acoustics is the reed (as in the reed pipes of the harmonium). The physics of reed pipes was first postulated by Wilhelm Weber in 1828.<sup>50</sup> He observed that

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<sup>46</sup> Ibid. p.1

<sup>47</sup> Jackson, Myles. *Harmonious Triads: Physicists, Musicians, and Instrument Makers in Nineteenth-Century Germany*. Cambridge, Mass.: MIT Press, 2006. pp. 24-31

<sup>48</sup> Wheatstone, C. On the Transmission of Musical Sounds through, Solid Linear Conductors, and on their subsequent Reciprocation. In *The Scientific Papers of Sir Charles Wheatstone*, 47-63 (originally published in *Journal of the Royal institution*, 2 (1831) p. 62

<sup>49</sup> Whitaker, R. "The Wheatstone kaleidophone." *American Journal of Physics* (1993) pp. 722-728

<sup>50</sup> Jackson, 2006, p. 114

the transverse vibrations of the reed and the longitudinal vibrations in an air column allowed for consistency of pitch under different intensities of airflow. Weber's perfected reed pipes for organs meant that the instrument could be played with more dynamic expressiveness than in the past.

Reeds were also used in speaking machines - the first speech synthesisers - as constructed by Wolfgang von Kempelen in 1769 and also by Wheatstone.<sup>51</sup> Vibrating reeds were also the basis of Wheatstone's new musical instruments, namely the symphonium<sup>52</sup> - a chromatic mouth organ, and the concertina (1829), which is still played and manufactured today.

If the late eighteenth and nineteenth centuries in Europe and the USA is considered as a period of standardisation in science, then it is equally true in music. The standardisation of tempo and pitch was of major concern to musicians, composers and instrument-makers but was achieved by physicists using the metronome, tuning fork and the siren. In Germany, the amateur physicist Johann Scheibler constructed an astonishingly accurate tonometer comprising fifty-six tuning forks, ranging from 220Hz to 440Hz, each being four vibrations per second sharper than the last. Scheibler used the tonometer to establish that the mean frequency of the concert A of Viennese pianos was 440Hz. While formally adopted by the German academy of sciences in 1834, it would take well into the twentieth century before this pitch became the international standard. Scheibler's tonometer was also significant for tuning pianos and other keyboard instruments to equal temperament.<sup>53</sup>

While Scheibler based his choice for a standard concert A on the average tunings of concert pianos, in France, the 'diapason normal', or standard pitch of A=435Hz adopted by the French in 1858, was the result of consultation with singers, composers (such as Hector Berlioz and Gioachino Rossini), instrument-makers and physicists, notably Jules Lissajous. Employing the same principle of Wheatstone's kaleidophone, Lissajous attached small mirrors to the tines of tuning forks. He was able to calculate the frequency of vibrating tuning forks by observing the geometric figures reflected by the mirrors.<sup>54</sup>

Tuning forks were also important in the physical sciences for the generation & study of combination tones. These are the additional tones perceived by the ear when two actual pitches are sounded in unison and are classified as either summation tones - being the sum of the two frequencies - or difference tones, the differential between them. The subject of combination tones led to a dispute between the leading scientific instrument maker of the age, Rudolf Koenig and the doyen of nineteenth century physics Hermann Helmholtz. Koenig, who began as a violin-maker and went on to create many of the

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<sup>51</sup> Wheatstone, C. "Reed Organ-Pipes, Speaking Machines, etc." *London and Westminster Review* (1837)

<sup>52</sup> <http://www.sites.hps.cam.ac.uk/whipple/explore/acoustics/wheatstonessymphonium/> (accessed on 05.06.2017)

<sup>53</sup> Jackson 2006, pp. 151-181, see also:

<http://www.sites.hps.cam.ac.uk/whipple/explore/acoustics/historicalnotes/> (accessed 05.06.2017)

<sup>54</sup> Jackson, 2006, pp. 210-13

scientific instruments used by Helmholtz in his acoustical experiments, believed that they were a product of the inner ear while Helmholtz was convinced that there was a class of combination tones that existed objectively, in nature, and set about proving their existence with the aid of the siren.<sup>55</sup>

Sirens were extremely valuable in showing that sounds are not only periodic vibrations as demonstrated by the tuning fork, but also pulsations of air. Through scientific instruments such as the tuning fork and the siren, physicists began to reconceptualise the notion of hearing and of sound.

Jackson ended his provocation with a discussion of how the boundary between scientific and musical instruments became blurred during the twentieth century. Tuning forks have been used in compositions by the likes of Warren Burt and Nicolas Bernier,<sup>56</sup> while sirens were used by Arseny Avraamov in the *Symphony of Sirens* (1922), George Antheil in the *Ballet Mécanique* (1925) and by Edgard Varèse in *Ionisation* (1929-31). Varese's use of the siren was not to evoke a factory, police or alarm sound but in order to create glissandi effects and liberate the sound from pitch relationships. The inspiration for *Ionisation* came from science; Varèse stated that the concept was that of "the process of atomic charge as electrons are liberated and molecules are ionised" and that he was "not influenced by composers as much as by natural objects and physical phenomena."<sup>57</sup> Varèse believed that composers must work with scientists and electrical engineers in order to produce new sounds and foresaw that physics and electricity would create a new musical aesthetic.

As the siren could be employed in a musical composition in order to challenge pitch relationships, so was the metronome used to liberate a composition from measured time. György Ligeti's *Poème symphonique* (1962) is scored for one hundred mechanical metronomes, each fully wound, all set to different speeds and set in motion by ten 'performers' as simultaneously as possible. As the metronomes wind down one after another and stop, periodicity becomes noticeable in the sound, and individual metronomes can be more clearly distinguished. The piece typically ends with just one metronome ticking alone for a few beats, followed by silence..."<sup>58</sup> Ligeti writes:

"As soon as some of the metronomes have run down, changing rhythmic patterns emerge, depending on the density of the ticking, until, at the end, there is only one, slowly ticking metronome left, whose rhythm is then regular. The homogeneous disorder of the beginning is called 'maximal entropy' in the jargon of information theory

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<sup>55</sup> Pantalony, David. *Altered sensations: Rudolph Koenig's acoustical workshop in nineteenth-century Paris* (New York : Springer, 2009) p.133

<sup>56</sup> see: <http://trove.nla.gov.au/work/16895271?selectedversion=NBD26051269> and <http://www.digicult.it/news/ars-electronica-prize-winners-nicolas-bernier-between-frequencies-and-dichotomies/> (both accessed 05.06.20167)

<sup>57</sup> Interview with Gunther Schuller (1965, p. 34), quoted in Erickson, Robert. *Sound Structure in Music*. (University of California Press, 1975)

<sup>58</sup> Ligeti, György. 1962. *Poème Symphonique 1962* for 100 metronomes – text score: <http://musicprisms.org/wp-content/uploads/2016/09/Poeme-Symphonique-for-100-Metronomes.pdf> (accessed 05.06.2017)

(and in thermodynamics). The irregular grid structures gradually emerge, and the entropy is reduced since previously unpredictable ordered patterns grow out of the opening uniformity. When only a single metronome is left ticking in a completely predictable manner, then the entropy is maximal again — or so the theory goes.”<sup>59</sup>

In this piece, Ligeti manages to create the moiré effect in sound; an analogue of the optical interference patterns in physics that manifest when two identical grids are placed over each other and one is rotated by a few degrees.<sup>60</sup>

In conclusion, Jackson argued, just as music and noise are historically contingent categories that were to be redefined throughout the late eighteenth, nineteenth and twentieth centuries, similarly the boundary between musical & scientific instruments, as well as the boundary between art and science, becomes blurred during this period.

An evening concert of new works programmed in response to the theme of Music and Noise was performed at the Science Museum by three of the workshop participants. Aleks Kolkowski’s *Sounding a Victorian Future* (2012-2015), consisted entirely of wax cylinder recordings reproduced mechanically on three early twentieth century Edison cylinder phonographs together with giant brass concert horns.<sup>61</sup> The piece used Kolkowski’s recent recordings of working machines in the Science Museum collection, including the reconstructed Charles Babbage’s Difference Engine, the Toyoda loom and the giant Burnley Mill engine.<sup>62</sup> All were transferred onto wax cylinders and the result of employing this antiquated format was to effectively ‘age’ the sound, as if to hear recordings of machines made in the distant past. The piece ended with an historic recording from 1888 containing a fragment from G.F. Handel’s oratorio *Israel in Egypt* (1739) - one of the earliest surviving recordings of live music known to exist.<sup>63</sup> The faintly recorded choir was buried in the loud surface noises from the heavily distressed original record, making the listening experience into a form of aural archeology. Sean Williams performed with a modular analog synthesiser, improvising around material and processes derived from *Funktionen* - a series of eight works by Gottfried Michael

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<sup>59</sup> Quoted in Steiniz, R. *Gyorgy Ligeti*. (London: Faber & Faber, 2003) p. 128

<sup>60</sup> Jackson, Myles. “From Scientific Instruments to Musical Instruments: The Tuning Fork, the Metronome, and the Siren.” In, *The Oxford Handbook of Sound Studies*, Trevor Pinch and Karin Bijsterveld (eds.). (New York: Oxford University Press, 2012) p. 217

<sup>61</sup> *Sounding A Victorian Future*, Aleks Kolkowski, first performed at TEDx, Imperial College, March 24<sup>th</sup>, 2012. Viewable on YouTube: <https://www.youtube.com/watch?v=AwW41wPQXQc> (assessed on July 25<sup>th</sup>, 2017).

<sup>62</sup> The Science Museum’s reconstructed Charles Babbage’s Difference Engine No. 2: <http://collection.sciencemuseum.org.uk/people/cp36993/charles-babbage>; Toyoda Power Loom: <http://collection.sciencemuseum.org.uk/objects/co528175/power-loom-weaving-loom>; Burnley Mill engine: [http://www.sciencemuseum.org.uk/sitecore/content/scim/visitmuseum/plan\\_your\\_visit/events/demonstrations\\_and\\_experiments/red-mill-engine](http://www.sciencemuseum.org.uk/sitecore/content/scim/visitmuseum/plan_your_visit/events/demonstrations_and_experiments/red-mill-engine) (all assessed on July 25<sup>th</sup>, 2017).

<sup>63</sup> One of three surviving cylinders recorded on July 29<sup>th</sup>, 1888 at the 9<sup>th</sup> Triennial Handel Festival, Crystal Palace, London of G.F. Handel’s oratorio *Israel in Egypt*, conducted by August Manns. The recordist was Col. George Gouraud, an agent for Thomas Edison and a note accompanying the cylinders reads: “A chorus of 4000 voices recorded with phonograph over 100 yards away”. See: <http://publicdomainreview.org/collections/excerpt-from-handels-israel-in-egypt-1888/> (assessed on July 25<sup>th</sup>, 2017).

Koenig composed between 1967–79.<sup>64</sup> Koenig had used a hybrid of tape, voltage control, and computer-based algorithmic techniques to compose and realise each *Funktion* piece, individually named after a colour but all based around the same 48 step sequence. They were made possible through the Variable Function Generator, a device designed by Stan Tempelaars at the Institute of Sonology, Utrecht.<sup>65</sup> Sarah Angliss and Caroline Radcliffe concluded the evening with a mixed-media performance. Their collaborative work *The Machinery*, combined recordings of machines, electronic music and video projection with live “machine-mimetic dance from the early nineteenth century” performed by Radcliffe.<sup>66</sup> The work explored the relationship between music and factory work through the medium of clog-dancing, presented here as a form of proto-industrial music. Devised by women working in the Lancashire mills, the steps of this nineteenth-century ‘heel and toe’ clog dance directly mimic the repetitive sounds and movements of cotton mill machines. The dance has survived being passed on by dancers with family associations with the mill, notably by the late Patricia Tracey (1927-2008).<sup>67</sup> The performance placed the dance in its industrial context by combining it with found sound and video shot in a working cotton mill as well as a modern telephone call centre, juxtaposing industrial manufacturing factory work with the modern-day service sector.<sup>68</sup>

The second day began with a hardware hacking workshop led by Tom Richards; a practical activity in which the participants were engaged in assembling simple electronic instruments from scratch, using circuit boards and other electronic components from a set of easy-to-follow instructions prepared by Richards. The assembly required no prior knowledge of electronics and, after a short period of time, the participants were able to produce a number of functioning light-sensitive theremins which they were able to play. The session ended in a spontaneous improvisation session involving a number of the newly created instruments played simultaneously. Reaction to the exercise was overwhelmingly positive, with many participants suggesting this become part of the proposed exhibition at the Science Museum in some form, either as a regular workshop activity as part of an accompanying events series or as a ‘build-it-yourself’ display within the exhibition proper. There was general consensus that the activity would appeal to both adults and children, and other ideas for hands-on building of working electronic instruments included the construction of something that could modify the sound of the visitors’ voices. This tactile, listenable activity brought into question the inability to hear the objects that were on display during Myles Jackson’s presentation on scientific instruments during the previous afternoon, asking how this could be addressed in an

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<sup>64</sup> Composer’s website: <http://www.koenigproject.nl/indexe.htm> (assessed on July 25<sup>th</sup>, 2017).

<sup>65</sup> Tempelaars, S. (Ed). *Signal Processing, Speech and Music* (Amsterdam: Swets & Zeitlinger, 1996) p.234

<sup>66</sup> Programme note by Sarah Angliss and Caroline Radcliffe. See: <http://www.sarahangliss.com/gigs/themachinery> (assessed on July 25<sup>th</sup>, 2017).

<sup>67</sup> Patricia Tracey’s obituary: <https://www.theguardian.com/music/2008/may/12/folk> (assessed on July 25<sup>th</sup>, 2017).

<sup>68</sup> Performance viewable on YouTube: <https://www.youtube.com/watch?v=pGEUhjWGQ2I> (assessed on July 25<sup>th</sup>, 2017).



exhibition context, either using recordings of the objects on display or digitally modelled versions of them. However, the experience of hearing an actual object sounding in space as opposed to listening to a recording of it is so great, that perhaps live demonstrations of certain artefacts, or working replicas of them, would be more effective in an exhibition on sound.

DIY electronics and the practice of physically modifying pre-existing electronic hardware (or 'hardware hacking'), has played a significant role in electronic music production in the twentieth century through to today. Trevor Pinch, in his provocation, drew from his own experiences as a musician and builder of a modular synthesiser, to examine the appeal of unpredictable and malfunctioning instruments in electronic music-making that are the wilful result of a practice known as circuit-bending. Coined by composer Reed Ghazala, the term refers to the bending of wires that link components within a electrical circuit.<sup>69</sup> Circuit-bending involves the taking of existing, battery-operated electronic devices and toys that produce sound, opening them up to expose their circuits and modifying them by adding new wire connections and by inserting variable resistors or switches to allow for a modicum of control over the resultant sound. The practitioner will often first experiment by touching an unaltered circuit with a wet finger in order to trigger inadvertent sounds and identify connections that produce these noises. Mass-produced electronic toys such as the Speak & Spell and the Furby have become classic tools of circuit-benders, allowing for exploration and experimentation with electronic hardware at very low cost and without requiring any previous knowledge of electronic engineering.<sup>70</sup> Books by Ghazala and Nic Collins and countless international workshops led by practitioners of circuit-bending have helped to spread its popularity,<sup>71</sup> while circuit-bent instruments, primarily intended for making experimental noise music, have now been embraced by popular artists such as Radiohead and Björk and are even sold ready-made.

Pinch made connections with the early work of synthesiser pioneers Robert Moog and Donald Buchla, in particular the latter's eschewing of the conventional organ type keyboard in order to create new user interfaces for electronic music production.<sup>72</sup> There are also strong links with the work of composers, notably Hugh Davies in Britain and David Tudor and Gordon Mumma in the U.S.A., who built their own experimental electronic instruments.<sup>73</sup>

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<sup>69</sup> Ghazala, R. *Circuit-Bending : Build Your Own Alien Instruments*. (Indianapolis: Wiley, 2005) p. 3 Reed Ghazala is known as the 'father of circuit-bending' (see front cover).

<sup>70</sup> A circuit-bent Texas Instruments "Speak and Spell" is found in the Science Museum collection: <http://collection.sciencemuseum.org.uk/objects/co8238729/speak-and-spell-childrens-toy-that-has-been-circuit-bent> (accessed 05.06.20167). For details on how to circuit-bend a 'Furby' toy, see: <http://circuit-bent.net/furby-bending-tutorial.html> (accessed 05.06.20167).

<sup>71</sup> Collins, N. *Handmade Electronic Music: The Art of Hardware Hacking* (New York: Routledge, 2006)

<sup>72</sup> Pinch, T. *Analog Days: The Invention and Impact of the Moog Synthesizer* (Harvard University Press, 2004)

<sup>73</sup> The Science Museum hold the Hugh Davies Collection, comprising "42 items of electronic sound apparatus owned by English experimental musician Hugh Davies (1943–2005), including self-built electro-acoustic musical instruments and modified sound production and manipulation hardware."

Mooney, J. [The Hugh Davies Collection: live electronic music and self-built electro-acoustic musical](#)

But the practice of electronic tinkering has a long history, going back to the 1920s and 30s with self-built radio sets, recording devices and instruments such as the Theremin, aided by hobbyist radio and electronics magazines.<sup>74</sup> The tactile approach to creating sounds and instruments is an important factor in the appeal of circuit-bending, as is the element of chance and unpredictability. In his interviews with circuit-benders, Pinch learnt that while a measure of control (or meta-control) is desirable, the instability of the instrument and potential for producing unexpected results is considered important, especially when playing in improvising situations. The circuit-bent device has an agency of its own, producing a glossolalia of electronic sounds almost unaided and in complete contrast to how it originally sounded as a commercially manufactured toy.

Circuit-benders push on the conventional milieu of musical instruments and technology, engaging in different practices of design and engineering of electronic instruments with a particular aesthetic of sound and performance that values malfunction, chance events, lack of expertise and even failure. While this work may be seen to express counter-cultural values, the circuit-bent instruments still need to be controlled and require a certain amount of stability in order to function. The increased popularity of circuit-bent instruments has led to their appearance in the fringes of mainstream music and exploitation as a commercial commodity.

The circuit-bender's "tactile understanding" of technology, which doesn't require knowledge of electronic schematics, enables them to take control of the technology. In a museum context, this would make circuit-bending an ideal learning activity, where visitors can engage in a tactile manner with the technology and at the same time gain an understanding of how electronically produced sound works.

Two radical counter-cultural musical genres extolling noise, from the 1970s until the present, are industrial and techno music. In industrial music's early period, a DIY aesthetic is also very much present, especially in the use of percussion instruments made from discarded metal objects, modified synthesisers and electronic effects. Alexei Monroe, in his provocation "A Violent Absence: Re-Industrialising the History of Noise in Music", stressed that no accurate narrative of the history of noise in twentieth century music is complete without fully discussing the role of noise in industrial & techno music. Industrial music has a troubled image and Monroe began by contrasting the critical acceptance of the Italian futurist movement, despite its affinity with Italian fascism and vehement glorification of militarism, with what he sees as the ostracising of industrial music by academics and music journalists because of its politically contentious and ambiguous nature. Futurism celebrated noise as a tool for anarchy and revolution,<sup>75</sup>

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instruments, 1967–1975 Published in [Spring 2017, Sound and Vision](http://dx.doi.org/10.15180/170705)  
<http://dx.doi.org/10.15180/170705>

<sup>74</sup> See: Douglas, S.J. *Listening In: Radio And The American Imagination*. (University of Minnesota Press, 2004)

<sup>75</sup> Marinetti, Filippo Tommaso. 2003. The Foundation and Manifesto of Futurism 1909. In, *Art in Theory, 1900–2000: an anthology of changing ideas*, Charles Harrison and Paul Wood (eds.). Oxford: Blackwell Publishing. p 146-149.

industrial music uses noise itself as power, through visceral amped-up loudness as well as symbolic visual representations of power, for and against ruling systems and even against audiences. Modern industrial music, Monroe argues, is a complex, contradictory mix of ambivalence, ambiguity, confrontation and social tension that was fomented during the 1970s - a period of rapid de-industrialisation, social unrest and upheaval in Europe and the U.S.A. Cabaret Voltaire and Throbbing Gristle are two British groups from this period that were highly influential and who in their music, made innovative use of noise, distortion, using self-built devices; synthesisers & electronic effects. It was Throbbing Gristle's record label Industrial Records, founded in 1976, that gave name to the new genre of industrial music that was strongly associated with dystopia, social and mental control, alienation and political and moral ambivalence. Monroe also sees the experimental electronic music of the BBC Radiophonic Workshop as a direct influence upon the industrial music of the 1970s and '80s, citing the incidental music created by Malcolm Clarke for *The Sea Devils* (1972) - an episode from the BBC children's television series *Doctor Who*.<sup>76</sup> For much of the general public, these television soundtracks were their first exposure to abstract electronic music outside the popular music realm and were to inspire and influence a generation of musicians.

Echos of russian constructivism and retro-futurism are evident in the industrial music of the 1980s, particularly in the work of the British performance group Test Dept. Monroe proffered Arseny Avraamov's *Symphony of Sirens* (1922), as the symbolic precursor to industrial music. This monumental work for the open air is a choreographed spectacle bringing together the sounds of the city, industry and military such as factory sirens; artillery; railways; docks; ships horns and whistles in a celebration of noise and the soviet worker's state. Avraamov was partially inspired by the writings of Alexei Gastev, avant-garde poet and proponent of scientific management or 'Taylorism' in the Soviet Union:<sup>77</sup> "The roar of morning factory sirens in the industrial suburbs is not a call to slavery but rather a song of the future."<sup>78</sup>

Avraamov was a pioneer of microtonal music and sound synthesis using sound-on-film techniques, who shortly after the October Revolution of 1917, proposed that all pianos should be burned.<sup>79</sup> While Russian constructivism is considered utopian, by contrast, industrial music is largely fixated on dystopianism, which Monroe argues, is used as a means of social reflection and as a "cathartic transmuting practice". Furthermore, he used Katharine Norman's assertion that: "Noise music fixates us by exerting control while promising ecstatic release",<sup>80</sup> to illustrate an underlying tenet of industrial music. The Slovenian group Laibach, formed in the early 1980s in Trbovlje, a former Yugoslavian mining town, is one of the few industrial music bands that come directly

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<sup>76</sup> See: <https://www.youtube.com/watch?v=k-YbsiU9bUY> (accessed on June 6<sup>th</sup>, 2017).

<sup>77</sup> See Kursell, 2006, p.1

<sup>78</sup> Alexei Gastev, quoted in *Baku: Symphony of Sirens: Sound Experiments in the Russian Avant Garde* CD and Book Publication (London: ReR MEGACORP, 2008) p.70

<sup>79</sup> Smirnov, A. *Sound in Z: Experiments in Sound and Music in Early 20<sup>th</sup> Century Russia* (London: Sound and Music/Koenig Books, 2013) p.30

<sup>80</sup> Norman, K. *Sounding Art. Eight Literary Excursions through Electronic Music* (Farnham: Ashgate, 2004)

from an industrial context. Their early work uses field recordings made in the factories and mines of the town where they and their relatives worked.<sup>81</sup> The group has courted controversy through its use of fascistic, neo-nationalist imagery and uniforms, however, Laibach's work is consciously ambiguous and ambivalent, drawing inspiration from the likes of economic and social theorist Jacques Attali:

"Music, the quintessential mass activity, like the crowd, is simultaneously a threat and a necessary source of legitimacy; trying to channel it is a risk that every system of power must run."<sup>82</sup>

Industrial music's tendency to dehumanise both musician and listener, like punk music, may be seen as a reaction to the personality-driven and virtuosic rock music of the period. This tendency was amplified, according to Monroe, as industrial music influenced the advent of techno in Detroit during the 1990s. Industrial music continues its relevancy within the political sphere today, an example being the industrial band Skinny Puppy's ongoing lawsuit against the United States government, who used the band's music as a sonic weapon of torture at the Guantanamo Bay detention camp.<sup>83</sup>

The discussion following Monroe's provocation considered other musics and art forms that have arisen from the industrial context but created by workers, such as singing in the workplace and clog dancing to give two examples, in contrast to the brutalist noise aesthetic of industrial music created by artists. It was suggested that in our post-industrial society, modern industrial music seems oddly nostalgic. The problem of how to best to represent industrial music and its radicalism within a museum context was pondered; it would be essential to provide ample video footage and visual material to adequately convey the controversial nature of the genre. Specific objects that could be exhibited include the "Gristle-iser" effects machine, used by Throbbing Gristle for making pounding echo effects;<sup>84</sup> Synthi AKS and Korg MS20 synthesisers; the E-MU Emulator 2 sampling keyboard as well as metallic 'junk percussion' instruments.

An emotional contagion binds musician and audience, according to Sarah Angliss in her provocation, much as Samuel Pepys, writing in his diary in 1668, described hearing music that 'made him sick'.<sup>85</sup> Angliss expressed curiosity regarding such deeply held emotional reactions to listening, likening the audience at a typically deafening noise concert to persons who attend an art exhibition because they wish to see a lot of the colour red, but who wouldn't be able to see the colour out of partial blindness for a few days afterwards. Making connections between such technologies and phenomena as the

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<sup>81</sup> Monroe, A. *Interrogation Machine – Laibach and NSK*. (MIT Press, 2005).

<sup>82</sup> Attali, J. *Noise: The Political Economy of Music* (University of Minnesota Press, 1977) p.14

<sup>83</sup> See: <https://www.theguardian.com/music/2014/feb/07/skinny-puppy-payment-guantanamo> (accessed on June 6<sup>th</sup> 2017)

<sup>84</sup> <http://www.endangeredaudioresearch.com/gristleizer-pedal/> (accessed on June 6<sup>th</sup> 2017)

<sup>85</sup> Pepys, Samuel. 2010. *The Diary of Samuel Pepys: Volume IX - 1668-1669: 1668-1669*. London: HarperCollins.

Watkins Copycat (an early tape echo effects machine),<sup>86</sup> heptaphonic echo,<sup>87</sup> and the so-called 'loudness wars' within the digital remastering community,<sup>88</sup> Angliss wondered why audiophiles are unable to accept the notion that recording fidelity perfection is impossible. The researcher Marc Perlman completed a sociological survey of audiophiles in 2004, dividing them into two major groups: 'golden ears' and 'meter readers,' with the former group desperate to listen to the highest quality recorded audio due to their belief in the precision of their own hearing abilities, while the latter group displays an addiction to audio technology and the need to acquire the latest, greatest technologies.<sup>89</sup> Perlman's studies claim that home Hi-Fi audio equipment is primarily a male domain, with many members of this group using their addiction to audio equipment as a way of reclaiming domestic space. In the follow-up discussion, Angliss, responding to a question about the sense of spectacle in live noise music and how this relates to emotional contagion, mentioned the importance of visual cues and gestures made by performers that are synchronised with the performed sound as being a cause of emotional contagion. The relationship between the desire to listen to extreme volume (noise music fans) and extreme silence (audiophiles) was also clarified as a matter of signal-to-noise ratio rather than of noise and silence. Angliss also presented the Kiki Bouba test, a visual test from the 1920s that connects shape with sound in a multimodal way.<sup>90</sup>

The ratio of signal-to-noise was purposefully low in an unusual provocation/performance by composer Luciano Chessa. In it, Chessa combined live readings with pre-recorded speech, digital noise and a megaphone to represent a metaphysical investigation of Luigi Nono's creation of a teleological musical form within the ending of his oft-performed composition *La lontananza nostalgica, utopica, futura* from 1988-89.<sup>91</sup> With much of the content of the talk obscured by either loud noise or the confusion of two voices speaking different texts simultaneously, Chessa created a tension between an explanation of purpose and that explanation's inability to be comprehended.

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<sup>86</sup> A filmed interview with Charlie Watkins, inventor of the Copycat, is available at: <https://www.namm.org/library/oral-history/charles-watkins> (accessed June 7<sup>th</sup> 2017)

<sup>87</sup> Described by Sarah Angliss in: <http://www.sarahangliss.com/portfolio/offthepage><http://www.sarahangliss.com/portfolio/offthepage> (accessed June 7<sup>th</sup> 2017)

<sup>88</sup> For a detailed account of the Loudness War, see: Milner, Greg. *Perfecting Sound Forever: The Story of Recorded Music* (London: Granta, 2009) pp. 237-292

<sup>89</sup> Perlman, M. Golden Ears and Meter Readers: The Contest for Epistemic Authority in Audiophilia, (*Social Studies of Science* Vol 34, Issue 5, 2004) pp. 783 - 807

<sup>90</sup> Robson, David. "Kiki or bouba? In search of language's missing link" *New Scientist* 13.07.2011: <https://www.newscientist.com/article/mg21128211-600-kiki-or-bouba-in-search-of-languages-missing-link/> (accessed June 7<sup>th</sup> 2017)

<sup>91</sup> *La Lontananza Nostalgica Utopica Futura*. Madrigal for several "travellers" with Gidon Kremer, solo violin, 8 magnetic tapes, and 8 to 10 music stands, composed in 1988-89. The final version of the tape was prepared together by Sofia Gubaidulina and Gidon Kremer in the Experimental Studio of the Heinrich Strobel Foundation, Südwestfunk Freiburg. See: <https://www.youtube.com/watch?v=X-CKVm8MXxU> (accessed June 7<sup>th</sup> 2017)

How do we qualify noise of a different order? Sally-Jane Norman, in her workshop summation, pondered this question while discussing the European Space Agency's artist residency programme,<sup>92</sup> which hosted a project in 2001 where a group of artists turned a radio telescope into a musical instrument, with the collected data from the transmissions being held in an open-source archive for others to study and remix.<sup>93</sup> In thinking about crafting an exhibition for the Science Museum, Norman suggested we think about the things we are currently training ourselves to listen to. In doing so, she suggested we think about the physicist and philosopher Karen Barad's post-humanist notion of intra-actions, which reverses contemporary opinions about causality and rethinks our relationship with objects, enacting boundaries of tuning and hearing in entirely different ways.<sup>94</sup> Norman also discussed different modes of listening, including empathic listening, which is "entirely oriented towards sensations produced and not towards what causes them" and figurativist listening, where sound is interpreted as narrative or as metaphors, and that "tends to think that certain sounds evoke something that moves, ultimately living."<sup>95</sup> In an exhibition context, would the Science Museum prefer to craft something empathic, where visitors feel a sense of connection with the objects they are listening to, or exhibition strategies focused purely on narratives and taxonomies? Perhaps a Science Museum exhibition on sound should focus on counterpoint, Norman argued, embracing its soundscape's own *sharawadji* - its unexplainable beauty through complexity.<sup>96</sup>

Sally-Jane Norman's summation provoked a group discussion that fittingly concluded the workshop series. The notion of new forms of material culture as potential museum exhibits was discussed in terms of an exhibition designed to offer a more immersive or multi-sensory experience, as well as the emergence of new modes of listening within our current culture. A museum exhibition about sound, which is inherently ephemeral, presents a new series of problems within an institution that is traditionally based in material culture. Norman views sound exhibited within museums with a notion of something salient emerging from an indiscriminate terrain. It was proffered that visitors should be confronted with a room filled only with sound, with absolutely nothing to look at or read, in order to force them to change their relationship with sound and the museum experience simultaneously, yet this also led to questions as to why such an

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<sup>92</sup> European Space Agency Art and Science residencies, in partnership with Ars Electronica: [http://www.esa.int/Our\\_Activities/Space\\_Science/Calling\\_all\\_artists\\_apply\\_now\\_for\\_art\\_and\\_science\\_residency](http://www.esa.int/Our_Activities/Space_Science/Calling_all_artists_apply_now_for_art_and_science_residency) (accessed June 7<sup>th</sup> 2017)

<sup>93</sup> The ESA's official SoundCloud channel hosts a multitude of sounds and so-called sonifications from Space, including the famous 'singing comet', a track that has been reused and remixed thousands of times by composers and music makers worldwide: <http://open.esa.int/esas-sounds-from-space/> (accessed June 7<sup>th</sup> 2017)

<sup>94</sup> Barad, Karen. "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter." (*Signs*, vol. 28, no. 3, 2003) pp. 801–831. *JSTOR*, [www.jstor.org/stable/10.1086/345321](http://www.jstor.org/stable/10.1086/345321).

<sup>95</sup> Empathic, figurativist and also taxonomic listening is discussed in: Delalande, François. "Music Analysis and Reception Behaviours: Sommeil by Pierre Henry" *Journal of New Music Research* 1998, Vol. 27, No. 1-2, pp. 13-66

<sup>96</sup> Augoyard, Jean François, Andra McCartney, Henry Torgue, and David Paquette (eds.). 2006. *Sonic Experience: A Guide to Everyday Sounds*. Montreal: McGill-Queen's University Press. p. 117-123.

experience would need to occur in a museum rather than on the radio or in a concert hall. Historical narrative is a logical reason to have a museum display, as museums are experts at presenting material within a historical context. Museums tend to be resistant to presenting material in an open or undefined way, yet it was suggested that this might be the exact method necessary in order to successfully present such an exhibition. The workshop ended with consensus that the importance of listening must be stressed in the proposed exhibition, in whatever form it may eventually take.

## Conclusion

The workshop series was organised ostensibly to garner ideas and narratives for a prospective exhibition that shows how science & technology has effected music-making in the late modern period. The focus on music, noise and silence and their interrelationships proved fruitful, not only in putting forward suggestions for artefacts that could be displayed in such an exhibition - mostly from within the Science Museum's Collections - but also examples from painting, literature and the inclusion of musical scores and notations. Many of these suggestions are explored in Tim Boon's accompanying commentary to this article, as are the implications for a future exhibition that is based on the multitude of ideas generated during the lively workshop discussions.

The fundamental importance of the visitors' listening experience in such an exhibition emerged as a dominant theme throughout the discussions, and for the creation of sonic environments within an exhibition that allow for different modes of listening; not only mediated by headphones, loudspeakers and sounding objects, but of listening in especially designed acoustic spaces, such as mobile anechoic and resonance chambers and separate rooms or enclosed spaces containing audio-visual installations. The entire soundscape of the exhibition could be organised or composed in such a way as to heighten a narrative arc, so as to encourage an interpretive form of listening where the visitor is taken on an aural journey through the exhibition spaces.

The emphasis on listening and the composition of a soundscape within the exhibition that could somehow avoid the cacophony of simultaneously sounding exhibits and installations while at the same time provide a form of sonic narrative is a challenging ambition, but in an exhibition about sound, it has to take precedence over the visual design and experience.