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Sara Lenzi is a researcher in data sonification and sound-driven design. She started her career as a sound designer in Italy, founding the first sound branding agency and winning Young Entrepreneur of the Year (2008). In 2012, she established Asia's first sound design studio, creating sound identities for spaces, products, and brands. Alongside, she continued her research and artistic activities through teaching and exhibitions worldwide. She earned a cum laude PhD in Design on Data Sonification from the Politecnico di Milano (2021).

She is a member of the International Advisory Board of the Design Research Society, a visiting researcher at Delft University of Technology, and an affiliate member of the Center for Design, Boston. She co-founded sounDesign.info and the Data Sonification Archive and has ongoing projects with MIT and City University of Hong Kong. An advocate for the importance of sound and listening, she emphasizes ethical responsibility in design. Her research focuses on data sonification for anomaly detection and design methods in sound design. Currently, she works at the Basque Foundation for Science Ikerbasque.

Spanish

Sara Lenzi es investigadora en sonificación de datos y diseño impulsado por el sonido. Comenzó su carrera como diseñadora de sonido en Italia, fundando la primera agencia de branding sonoro y ganando el premio a la Joven Emprendedora del Año (2008). En 2012, estableció el primer estudio de diseño de sonido en Asia, creando identidades sonoras para espacios, productos y marcas. Paralelamente, continuó su investigación y actividades artísticas a través de la enseñanza y exposiciones en todo el mundo. Obtuvo un doctorado cum laude en Diseño sobre Sonificación de Datos del Politecnico di Milano (2021).

Es miembro del Consejo Asesor Internacional de la Design Research Society, investigadora visitante en la Universidad Técnica de Delft y miembro afiliada del Center for Design de Boston. Cofundó sounDesign.info y el Data Sonification Archive, y tiene proyectos en curso con el MIT y la City University de Hong Kong. Defensora de la importancia del sonido y la escucha, enfatiza la responsabilidad ética en el diseño. Su investigación se centra en la sonificación de datos para la detección de anomalías y los métodos de diseño en el diseño sonoro. Actualmente, trabaja en la Fundación Vasca para la Ciencia Ikerbasque.

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Hearing data: Combining sensory experiences for improved human-data relationships.

"In the past two decades, the collection, production and consumption of data has exponentially increased at all levels of human endeavours. As most of the infrastructures we use to deal with, from communications to public utilities, transportation, education transitioned from the physical towards the digital world - thanks to, for instance, the Internet of Things, smart networks, smart phones, smart devices, or social media - new challenges have arisen on how to make sense of this unprecedented amount of data and translate it into human-scale information, and thus knowledge (Masud et al., 2010).

Of all human senses, hearing is the first to develop. Even before birth we learn to distinguish the mother's voice and identify familiar sounds from within the womb. Our everyday relationship with sound keeps growing all over our lives. Human capability to gather environmental information from surrounding sound events is extremely sophisticated, as well explored and described since the 1960s by the research area of soundscape studies (Schafer 1977, Truax 2000) . Recently, the COVID pandemic has reminded us how much our everyday lives are impacted by the urban soundscape: In the absence of human-generated sounds such as car traffic, constructions, and voices of crowd's in the streets, cities around the world seemed empty and even eerie. In functional socio-technological environments, we use sound to gather information and perform tasks:

The coffee machine tells us that coffee is ready by the distinct sound it makes when it pours. Nurses monitor the patient's status by hearing the sounds of medical equipment. While driving, we know whether the car is correctly functioning by listening to the sound it emits - while we can still keep our eyes on the road. Although we are scarcely aware of it, the act of listening is a continuous act of knowing and interacting with the world around us (Lenzi et al., 2024). Over the decades, designers (and to some extent, artists) have used sound to create sonic experiences that not only convey information but also emotionally engage the public. At cinema or in digital gaming, sound is designed to shape and direct the experience of time, space, and narrative (Hilmann & Pauletto 2014). In product design, sound is more and more used both functionally - to provide feedback and guide interaction with a product - and aesthetically - to engage customers with a brand. In electric cars, the 'fake' engine sound originally added to alert pedestrians has become a key element of the user experience, with manufacturers working with sound designers and composers to shape their product's distinct identity (Misdariis et al., 2012).

In our data-intense society, data sonification - which uses sounds to represent and communicate large data sets - is gaining momentum as an alternative or a complement to data visualisation both as a tool for analysis and a means of mass-communication of complex phenomena.

Data Sonification: Listening is making sense

Although many readers might be familiar with one of the most successful cases of data sonification - the Geiger Counter, through which we can monitor in real-time the amount of radiations in the environments by listening to a pulsating sound which frequency over time increases proportionally to the amount of radiation - Data Sonification is a relatively young field of research. It was first officially defined after the 1992 International Conference on Auditory Display as a method for "the transformation of data relations into perceived relations in an acoustic signal" (Kramer 1994). Originally a field of research close to computer science and focussed on providing expert tools for data analysis (Hermann et al. 2011), in recent years sonification has grown to show a variety of other purposes - from public communication to data journalism and even activism (Lindborg et al. 2024). Besides being used to represent and communicate 'objective' (numerical) values, authors of sonifications are putting more effort on the aesthetic quality of the user experience - which might, in turn, support a deeper understanding of the phenomenon, especially when the data refer to socially relevant issues (Lenzi and Ciuccarelli 2020).

The Data Sonification Archive (DSA), the first online collection of sonification projects, is a crowdsourced initiative launched in early 2021 that collects more than 450 cases to date (Lenzi et al., 2021). A quick analysis of the DSA shows how sonification is more and more used to engage a non-specialised audience with socially relevant, complex phenomena such as climate change, the recent COVID pandemic, social inequality, human rights. Not only experts in sound computing, but also artists, journalists, and information designers are starting to integrate sound into their data experience to improve the understanding of the final user by engaging them with the complexity of the data (and the phenomenon they represent) at a more visceral level.

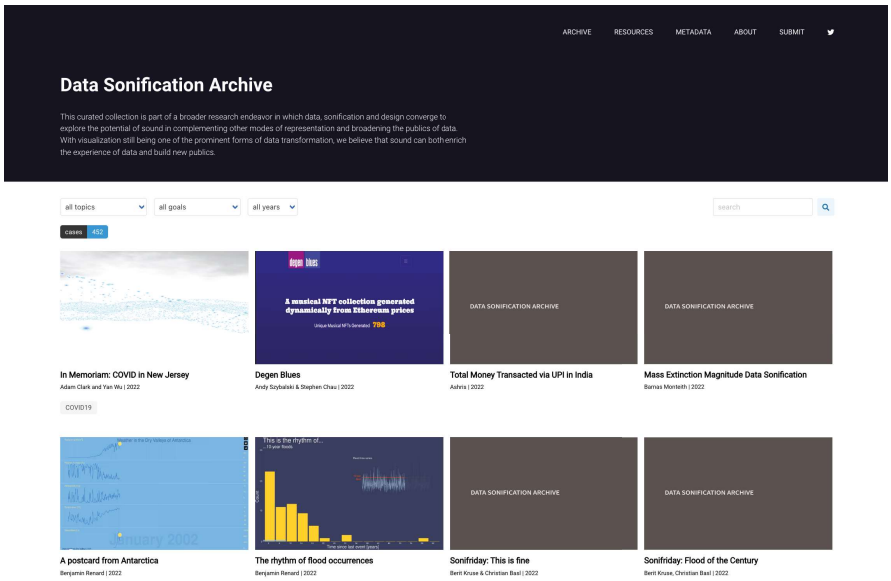

Figure 1. The Data Sonification Archive, the first online collection of sonification projects (https://sonification.design).

Figure 2. An image capturing the deadly wildfire season of 2023 in Canada, which burnt more than 15 millions hectares of wildforest. Photo by Duncan Rawlinson (CC Creative Commons 4.0). https://www.flickr.com/photos/thelastminute/

In Hold the Line, Miriam Quick and Duncan Geere - also authors of the Loudnumbers podcast where sonification projects are explained in detail, for non-experts - a piece of soundart was created to represent the loss of more than 5% of the Canadian forests over the course of 2023 due to the most tragic season of wildfires in the history of North America, fuelled by climate change. In the sonification, 'Every single fire that was reported by the Canadian Interagency Forest Fires Centre between 1 April and 30 November is represented by a click sound, with each real-world day playing out over 2.5 seconds of sound. A bass note drops at the start of each new day'.

In Digital Violence, the investigative team of Forensic Architecture teamed up with the musician Brian Eno to compose a piece that sonifies the data collected by Amnesty International on the Pegasus Project - the systematic surveillance and human rights violations conducted by the NSO group on activists and journalists worldwide. Through sound, people can 'experience a sonic rendering' that engages at a deeper level than the visual representation of the same data set through graphics and diagrams.

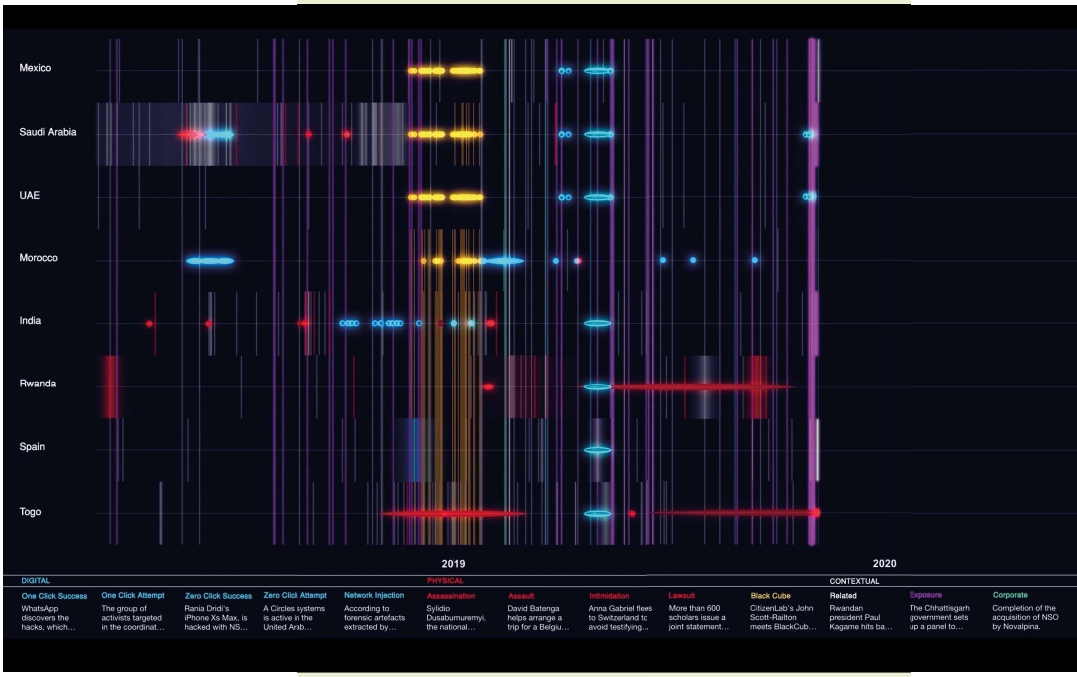

Figure 3. Digital Violence is a research and activism project by Forensic Architecture that traces and accounts for the illegal surveillance and human rights violation activity conducted by the company NSO worldwide. In the image we see an excerpt of the sonification of the same dataset by the composer Brian Eno. https://www.digitalviolence.org/#/soundmachine

In Requiem 488 by Nessun Dharma, data sonification and visualisation are combined in a threnody for the COVID victims in the Italian provinces of Bergamo and Brescia, where the pandemic was most deadly. In the piece, every second represents a day from January 1st 2020 to March 18rh 2022. Every death caused by COVID is simultaneously represented by a sound event and a visual dot to create a narrative where 'the dramatic development of the work follows moments of high intensity caused by the so-called "waves" and moments of relative calm'.

In collaboration with NASA, System SOUNDS is a sci-art project that has extensively worked to 'translate the rhythm and harmony of the cosmos into music and sound' for public outreach. Thanks to sonification and interactive sound experiences, science is brought closer to non-expert audiences and made accessible to visually impaired people.

Figure 4. In 'Requiem 488' by Nessun Dharma, data from the COVID deaths in the two most affected provinces of Italy are visualised and sonified in an immersive installation where each sound event and visual element represent a life that was lost due to the pandemic. https://www.youtube.com/

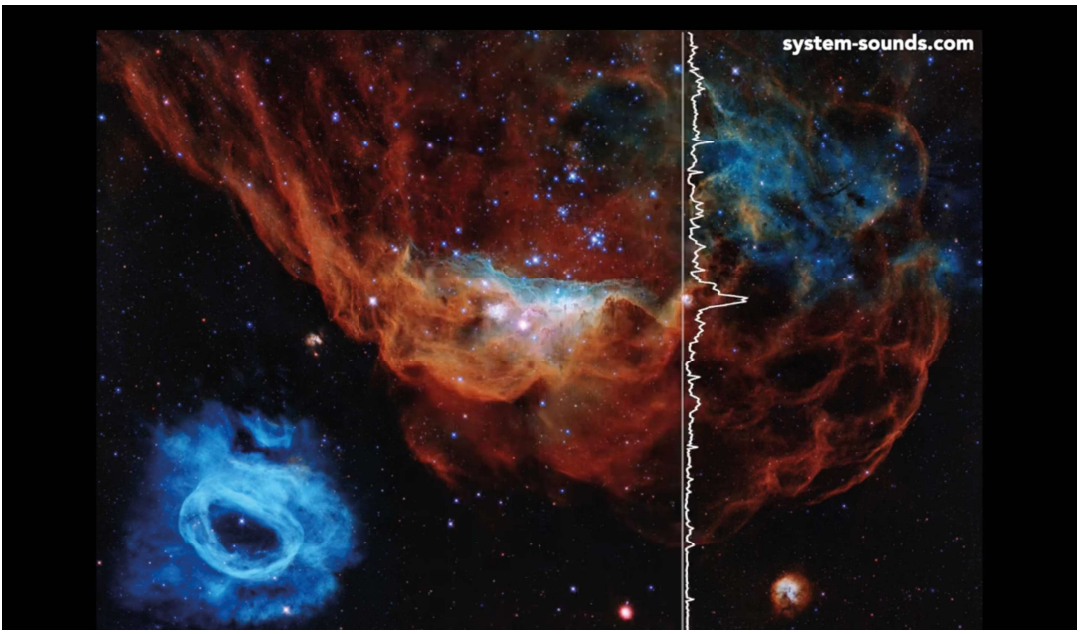

Figure 5. Sonification of images of the Cosmic Reef collected by the Hubble Space Telescope. In the sonification, colour is mapped to pitch (red=low, blue=high) and brightness controls volume. https://www.youtube.com/watch?v=kRkkHDEo0zQ

Open challenges and the role of designers

All the examples presented in this article leverage characteristics of sound that can add value to our understanding of a dataset. For instance, the human ear is very good at detecting changes in the acoustic patterns of sound events (Vickers 2011). Sound can attract our attention without requiring visual attention (Ballatore et al. 2018) so that we can keep focus on other - mainly visual - activities. Consequently, sound can provide a 'peripheral monitoring' system i.e. an alert system that stays at the background of our attention unless it is needed (Bakker et al. 2012), such as it happens with alarms emitted from medical equipment. Additionally, sound composition is inherently multivariate: different acoustic parameters (pitch, amplitude, rhythm, timbre) coexists in the same 'temporal unit' although they can be individually distinguished: For example, while listening to an orchestra we can distinguish a trumpet from a violin, or when in a natural soundscape we can identify different bird calls (Chion 2016).

While the use of sonification is growing among information designers, a series of critical open questions are still preventing the field from having a real-world impact. For instance, unlike data visualisation, whose long history has standardised the rules to translate specific data variable to visual variable to universal understanding (Muntzner 2015), in data sonification it is still unclear which 'data-to-sound' mapping works better. Can we use music that sounds 'happy' to represent a problematic issue such as income inequality - such as it happens in Two Trains by the Data Driven DJ - or is a 'wrong' choice of sound material misleading the listeners and even potentially spreading misinformation? Are blind listeners interpreting the changes in sound over time the same way as sighted listeners? A famous experiment by Walker and Lane (2001) - which showed how sighted and non-sighted users interpreted sonified data on growing economic value in opposite directions - suggests that is not the case. Could the introduction of shared design methods (such as the Data Sonification Canvas by Lenzi and Ciuccarelli, 2020) which include a thorough analysis of the use case and the evaluation of the impact help structure the field and uncover the full potential of sound for data representation?

As a young discipline, data sonification is still struggling to uncover its full potential. Perhaps design, as a structured discipline which fosters a multi-disciplinary approach to complex (wicked) problems, can provide the framework needed to create better, more engaging and inclusive data representations. As we move towards a world where humans will have to relate with non-human or more-than-human intelligences, sound can represent a truly embodied, visceral, pre-semantic means of communication towards better human-data relationships.

References:

Bakker, S, van den Hoven, E and Eggen, B. (2012). Knowing by ear: leveraging human attention abilities in interaction design. J. Multimodal User Interf. 5, 197–209. doi: 10.1007/s12193-011-0062-8.

Ballatore, A, Gordon, D and Boone, A P. (2018). Sonifying data uncertainty with sound dimensions. Cartography Geog. Inform. Sci. 46, 85–400. doi: 10.1080/15230406.2018.1495103.

Chion, M. (2016). Sound: An Acoulogical Treatise. Durham, NC: Duke University Press.

Guillarme, A. (2011). "Intelligent Auditory Alarm," in The Sonification Handbook, eds. T. Hermann, A. Hunt, J. G. Neuhoff. (Berlin, Germany: Logos Publishing House), 493–508.

Kramer, G. (1994), An introduction to auditory display. In Gregory Kram - er, (ed.), Auditory Display, volume XVIII of Santa Fe Institute, Studies in the Sciences of Complexity Proceedings, (Reading, MA, Addison-Wesley), pages 1–78.

Hermann, T, Hunt, A and Neuhoff, J. G., eds. (2011) The Sonification Handbook. Berlin, Germany: Logos Publishing House.

Hilmann, N and Pauletto, S (2014) The Craftsman: The use of sound design to elicit emotions. The Soundtrack 7(1).

Lenzi S, Ciuccarelli P, Liu H and Hua Y. 2021. Data Sonification Archive. http://www.sonification.design.

Lenzi S & Ciuccarelli, P. (2020). The Sonification Canvas. doi: 10.13140/RG.2.2.20307.66084.

Lenzi, , & Ciuccarelli, P. (2020). Intentionality and design in the data sonification of social issues. Big Data & Society, 7(2). https://doi.org/10.1177/2053951720944603.

Lenzi, S, Ciuccarelli, P & Offenhuber, D. (2024). 'Towards a definition of Autographic Sonifications: Listening as an act of knowledge.' Design Research Society Conference, 25-30 June, Northeastern University, Boston. In press.

Lindborg, PM, Caiola, V, Man, C, Ciuccarelli, P & Lenzi, S. (2024). Re(de)fining Sonification: Project Classification Strategies in the Data Sonification Archive' Journal of the Audio Engineering Society of America. In review.

Masud, L, Valsecchi, F, Ciuccarelli, P, Ricci, D, and Caviglia, G. (2010). From data to knowledge: visualizations as transformation processes within the data-information-knowledge continuum. Proc Int Conf Inf Vis. 2010, 445–449. doi: 10.1109/IV.2010.68.

Misdariis, N, Cera, ., Levallois, E and Locqueteau, C. (2012). Do electric cars have to make noise? An emblematic opportunity for designing sounds and soundscapes. Acoustics 2012, Apr 2012, Nantes, France. ⟨hal-00810920⟩

Munzner, T. (2015). Visualization Analysis and Design. CRC Press.

Schaefer M R (1977) The tuning of the world. New York : A.A. Knopf, 1977.

Truax, B. (2000). Acoustic Communication (Second Edition). Ablex Publishing: London.

Vickers, P. (2011). "Sonification for process monitoring," in The Sonification Handbook, eds. T. Hermann, A. Hunt, J. G. Neuhoff (Berlin, Germany: Logos Publishing House), 455–491.

Walker, B and Lane, D (2001) Psychophysical scaling of sonification mappings: A comparison of visually impaired and sighted listeners in Proceedings of the 7th International Conference on Auditory Display. July 29th - August 1st, 2001. Helsinki University of Technology.

proyecta 56

An industrial design journal