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ORIGINAL ARTICLE

What NMSAT says about sonification

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Abstract This article presents a sample of references issuing directly from the existing NMSAT database. The method employed—that of systematically probing the database—reveals forms of sonification, but also hypothetical premises of sonification, covering the period from ancient times to the beginning of the twentieth century. The following are some of the categories of sonification that have emerged as a result of this search: Natural phenomenon & meteorology to sound (autophones); Image to sound; Text & communication to sound; Human & machine activities to sound (auditing); Localisation to sound (sonar); Architecture & geometry & abstract proportions to sound (scalization, transcription, & spatialization); Energy to sound; Human body to sound; Distance to sound (distance listening); Movement to sound (holophony, kynophony); and Interpreted observations to sound (naturalist music, transpositions & analogies, paraphrasing). The search also uncovered other principals and practices in the vicinity of sonification including: audification, auditing, auscultation, auralization, soniculation, transduction, mapping, earcons, auditory icons, sympathy, echometry, etc. It has been decided to summarise the results of « What NMSAT Says About Sonification » in this special issue of AI&Society, access to the unabridged version of article is available here: http://www.locusonus.org/sonification/.

Keywords Sonification history · Distance listening · Networks · Audio art · Networked music · Timeline · Database

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1 Introduction

NMSAT "Networked Music & SoundArt Timeline" is simultaneously a historical documentary database and a monitor of the evolution of networked music and sound art. Jerome Joy initiated the project in 2008 as part of Locus Sonus' research program. The aim is to provide an overview of practices and techniques in the realm of networked music and sonic performance, from ancient history to the present day, through a collection of references to theoretical and critical texts, thereby offering a valuable resource available to artists and researchers.

A future version of NMSAT will be publicly accessible online, open to contributions, and collectively moderated by an international college of more than sixty artists and researchers. It will also become an editorial platform for analytical studies and other projects related to sound transmission and distance listening.

2 Entries

2.1 ca. 3500 BC: Ancient Systems of Accounting

Comment: The presence of auditing ("hearing of accounts" from the Latin "auditus") has been inferred from records of Mesopotamian civilizations going back as early as 3500 BCE. To ensure that the Pharaoh was not being cheated, auditors compared the "soundness" of strictly independently scribed accounts of commodities moving in, out and remaining in warehouses (Boyd 1905). In the alternating intoning of such lists, differences can be easily identified aurally. A faster and more secure method that eliminates any "copy-cat" syndrome in such alternation, is to have the scribes read the records simultaneously a type of modulation

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differencing technique. While we have no evidence that these techniques were practiced in ancient times, such a suggestion does not seem unreasonable, and would represent possibly the earliest form of data sonification. (David Worrall—published with the author's agreement)—[Ed.: This reference is an inference of Boyd's account by Worrall.]

2.1.1 Attached references

E. Boyd. (1905). History of auditing (1326); Mathieu-François-Régis Buisson (1776–1804), Auscultation (1802); René-Théophile-Marie-Hyacinthe Laënnec (1781–1826), On Mediate Auscultation (1819); Dr. Benjamin Ward Richardson (1828–1896), Sphygmophone (1879); Dxing (1920); Car mechanics, Listen to the engine, Mechanic's stethoscope; Listen to the code, Code Smell; Codesounding.

2.1.2 Sources

E. Boyd. (1905). Ancient Systems of Accounting. In "A History of Accounting and Accountants," edited by Richard Brown. Chapter II. Edinburgh: T.L & E.C. Jack and Augustus M. Kelley Publishers; and also: General Books LLC publication, 2009, pp. 13–17; D. Worrall. (2009). Sonification and Information—Concepts, Instruments and Techniques. PhD thesis, University of Canberra, p. 2–1.

2.2 **ca. 540 BC: Musica universalis**

*2.2.1 Pythagoras of Samos (Pythagore) (*Πυθαγόρας, *Pythagóras) (ca. 580–497 BC)*

Translated excerpt: « [985b] […] At the same time, however, and even earlier the so-called Pythagoreans applied themselves to mathematics, and were the first to develop this science; and through studying it they came to believe that its principles are the principles of everything. And since numbers are by nature first among these principles, and they fancied that they could detect in numbers, to a greater extent than in fire and earth and water, many analogues of what is and comes into being—such and such a property of number being justice, and such and such soul or mind, another opportunity, and similarly, more or less, with all the rest—and since they saw further that the properties and ratios of the musical scales are based on numbers, and since it seemed clear that all other things have their whole nature modelled upon numbers, and that numbers are the ultimate things in the whole physical universe, [986a] they assumed the elements of numbers to be the elements of everything, and the whole universe to be a proportion or number. Whatever analogues to the processes and parts of the heavens and to the whole order of the universe they could exhibit in numbers and proportions, these they collected and correlated; and if there was any deficiency anywhere, they made haste to supply it, in order to make their system a connected whole. […] » (Aristotle, Metaphysics, Metaphysica A 5. 985 b, 986a, Translated by Hugh Tredennick).

2.2.2 Attached references

Philolaus (Φιλόλαος Philólaos) (ca. 470–385 BC), Bacchae, On Nature; Plato (Πλάτων/Plátôn) (ca.428–427 BC—ca. 347–346 BC), Timaeus (ca. 360 BC); Claudius Ptolemaeus (Κλαύδιος Πτολεμα□ος Klaúdios Ptolemaîos) (Ptolemy) (ca. AD 90–ca. 168), Harmonics; Anicius Manlius Severinus Boëthius (Boethius) (ca. 480–524), De Institutione Musica (Fundamentals of Music); Guido of Arezzo (Guido Aretinus; Guido da Arezzo; Guido Monaco) (991/992—ca. 1033), Micrologus (1025); Anonymous, Naturalis concordia vocum cum planetis (ca. 1100); Johannes de Muris (Jean de Murs; Johannis de Muris; Jean de Muris; Jehan des Muris) (ca. 1290–1350), De sonis musicis (1319), Ars novæ musica (1319), Musica speculativa secundum Boethium (1323); Adrian Willaert (ca. 1490–1562), Salmi Spezzati (1550); Gioseffo Zarlino (1517–1590), Le Istitutioni Harmoniche (1558); Adrian Willaert (ca. 1490–1562), Giovanni Gabrieli (ca. 1554/1557–1612), Cori Spezzati (ca. 1590); Johannes Kepler (1571–1630), Harmonices Mundi (1619); Michael Praetorius (1571–1621), Syntagma musicum (1619); Orazio Benevoli (1605–1672), Te Deum (Missa Salisburgensis) (1628).

2.2.3 Source

Aristotle. (-350 B.C.). Metaphysics. In "Aristotle in 23 Volumes." Vols.17, 18. Translated by Hugh Tredennick. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1933, 1989.

2.3 **ca. 500 BC: *Æ*olian harp**

Comment: « Winter—Jan. 28, 1852—No music from the telegraph harp on the causeway, where the wind is strong, but in the Cut this cold day I hear memorable strains. What must the birds and beasts think where it passes through the woods, who heard only the squeaking of the trees before ? I should think that these strains would get into their music at last. Will not the mockingbird be heard one day inserting this strain in his medley ! It intoxicates me. Orpheus is still alive. All poetry and mythology revive. The spirits of all bards sweep the strings. I hear the clearest silver, lyre-like tones, Tyrtœan tones. I think of Menander and the rest. It is the most glorious music I ever heard. All those bards revive and flourish again in that 5 min in the Deep Cut. The breeeze

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came through an oak still wearing its dry leaves. The very fine clear tones seemed to come from the very core and pith of this telegraph-pole. I know not but it is my own chords that tremble so divinely. There are barytones and high sharp tones, etc. Some come sweepingly from further along the wire. The latent music of the earth had found here a vent. Music Æolian. There were two strings, in fact, on each side. I do not know but this will make me read the Greek poets. Thus, as ever, the finest uses of things are accidental. Mr. Morse did not invent this music. […] There are some whose ears help so that my things have a rare significance when I read to them. It is almost too good a hearing, so that for the time I regard my own writing from too favorable a point of view. […] » (Henry David Thoreau, 1852).

2.3.1 Attached references

Hermes (Mercury), Homeric Hymn (ca. -522 BC); St. Dunstan (909–988), quoted in John Foxe, (1583); Shishi Odoshi (ししおどし, 鹿威し) (deer scarer)—Fuurin (風鈴—ふうりん—huurin) (wind bell)—Sōzu (そうず, 添水) (water fountain) (ca. 1300); King David's harp, In Midrash; John Foxe (1517–1587), Dunstan's harp (909–988) (1583); Giambattista Della Porta (1535–1615), Magiae Naturalis (1558); Suikinkutsu (水琴窟) (Water koto cave) (ca. 1600); Ji Cheng (1582–ca. 1642), Shakkei (借景) & ikedori (Borrowed scenery) (1634); Athanasius Kircher (1601–1680), Musurgia Universalis (1650), Phonurgia Nova (1673); Carillons (1652); Samuel Taylor Coleridge (1772–1834), The Æolian Harp (1796); Percy Bysshe Shelley (1792–1822), Ode to the West Wind (1819); Hector Berlioz (1803–1869), The Æolian Harp (Lélio ou le retour à la vie—H 55, op. 14b) (1832); Frédéric Chopin (1810–1849), Etude in A flat major for piano (1836); Rodolphe Radau (1835–1911), L'Acoustique ou les Phénomènes du Son (1867); Sergei Mikhailovich Lyapunov (1859–1924), 12 Transcendental Etudes Op.11 No.9 (1905); Lord Rayleigh (1842–1919), Æolian Tones (1915); Henry Cowell (1897–1965), Æolian Harp for piano (1923); Jan Garbarek (1947-), Dis (1976); Alan Lamb (1944-), Primal Image (1995); Douglas Kahn (?-), Aelectrosonic (2009).

2.3.2 Sources

H. D. Thoreau (1852). Journal. Vol. 3, pp. 219–220, New York: Houghton Mifflin; cited by Allen S. Weiss, In "Varieties of Audio Mimesis: Musical Evocation of Landscape", coll. « Audio Issues » Vol. 3, New York/Berlin: Errant Bodies Press, 2008; Middrash Rabbah. Michael Miller, Midrash Ha-Mevo'ar Institute (Eds). Stiftung Irene Bolleg-Herzheimer, Basel, Feldheim Publishers, 2002; and also some references in: Bible, Ancient Testament, Books of Samuel; J. Foxe. (1583). The acts and monuments of John Foxe. Vol. II, p. 103. Edited By Stephen Reed Catley. London: R.B. Seeley and W. Burnside, sold by L. & G. Seeley, 1837.

2.4 ca. 400 BC: On Mathematics

*Archytas of Tarentum (Ἀρχύτας/Arkhytas) (*ca.*428–350 BC)*

2.5 1326: History of auditing *Referenced by E. Boyd (1905)*

2.6 1436: Nuper Rosarum Flores (Recently Flowers of Roses/The Rose Blossoms Recently)

2.6.1 Guillaume Dufay (1397–1474)

Comment: "Nuper Rosarum Flores" is an isorhythmic motet composed in 1436 by Guillaume Dufay, to be performed at the consecration of the new Florence cathedral on the occasion of the completion of the dome designed by Filippo Brunelleschi. The motet is striking for its synthesis of both the older isorhythmic style and the new contrapuntal style, which would be developed in the coming decades by Dufay himself as well as his successors (such as Ockeghem and Josquin des Prez). The title of the piece stems from the actual cathedral itself, which was named Santa Maria del Fiore, or St. Mary of the Flower. The musicologist Charles Warren claimed that the proportional structure of the motet mimicked the proportions of the building itself (Warren 1973). David Fallows (1987, 283 n46), Charles Turner (1991, 99–102) [Ed.: This was later refuted by Craig Wright (Wright 1994, 401, 404–407)] (Comment under Creative Commons CC-BY-SA license, In Wikipedia: The Free Encyclopedia. Wikimedia Foundation. Retrieved October 31, 2010).

2.6.2 Sources

M. Trachtenberg. (2001). Architecture and Music Reunited: A New Reading of Dufay's "Nuper Rosarum Flores" and the Cathedral of Florence. In "Renaissance Quarterly" 54 (2001), pp. 740–775; C. Warren. 1973. Brunelleschi's Dome and Dufay's Motet. In "The Musical Quarterly" 59:92–105; D. Fallows. 1987. Dufay. Revised edition. The Master Musicians Series. London and Melbourne: J. M. Dent & Sons Ltd; C. Turner. 1991. Proportion and Form in the Continental Isorhythmic Motet c. 1385–1450. In "Music Analysis" 10, no. 1/2 (March–July): 89–124; C. Wright. 1994. Dufay's Nuper rosarum flores, King Solomon's Temple, and the Veneration of the Virgin. In "Journal of the American Musicological Society" 47, no. 3 (Fall): 395–441.

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2.7 **1483: Underwater acoustics**

2.7.1 Leonardo da Vinci (1452–1519)

Comment: "If you let your ship stop and dip the end of a long blowpipe in the water and hold the other end to your ear, then you can hear ships which are very [far] distant from you" (Leonardo da Vinci, 1483; quoted in "Fundamentals of noise and vibration", 1998, edited by Frank Fahy & John Gerard Walker, Taylor & Francis, p. 375).

2.7.2 Attached references

Jean-Daniel Colladon (1802–1893), measure of the sound velocity in the waters of Lake Geneva (1826); Lazzaro Spallanzani (1729–1799), theory of echolocation (1794); Pierre Curie (1859–1906) & Jacques Curie (1856–1941), piezoelectric effect (1880); Alexander Belm (?), underwater echo-sounding device (1912); Lewis Fry Richardson (1881–1953), underwater echo ranging sonar (1912); Reginald Fessenden (1866–1932), sonar (1914); Paul Langevin (1872–1946) & Constantin Chilowski (?), Hydrophone—high frequency ultrasonic echo-sounding device w/piezoelectric transducer (1917); Sir Edward Victor Appleton (1892–1965), use of radio echoes to determine the ionosphere's height (1924); Sir Robert Alexander Watson-Watt (1892–1973), RADAR system (1935).

2.8 **1619: Harmonices Mundi** (The Harmony of the World)

2.8.1 Johannes Kepler (1571–1630)

Translated excerpt: « Book IV of the Harmony of the World by Johannes Kepler—On the harmonic configurations of the stellar rays on the earth, and their effects on events in the sky and other natural phenomena—On the use of mathematics in Natural Philosophy and Politics which most of all concern the Harmonic part of it on radiations. It furnishes everything that is important for the contemplation of nature, declaring the most splendid order of the ratios, according to which the whole of this universe has been constructed, and the analogy of the proportions, which connects together everything in the world, as Timaeus says somewhere, and which restores friendship between things which are in conflict, and relations and mutual affection between those which are widely separated. […]—Book V of the Harmony of the World by Johannes Kepler—[…] Chapter VI—That in the Extremes of the Planetary Motions Have Been Expressed, in a Fashion, the Musical Modes or Tones—Yet by the designation of two notes in a common system, and the shaping of the skeleton of the octave, by spanning a definite melodic interval, there is a certain first step towards distinguishing tones or modes: therefore the musical modes have been distributed among the planets. To be sure I know that for the shaping and defining of distinct modes many things are needed, which are proper to human melody, that is to say when it has intervals; and so I have used the voice in a fashion. Now it will be open to a musician to draw his own conclusion as to which mode each planet more nearly expresses, now that the extremes have here been assigned for him. […] » (Transl. by E.J. Aiton, A.M. Duncan, J.V. Field).

2.8.2 Sources

J. Kepler. (1619 [1997]). The Harmony of the World. Tr.: E.J. Aiton, A.M. Duncan, J.V. Field. The American Philosophical Society (Eds), 1997.

2.9 **1627: Sylva Sylvarum: Or a Natural History in Ten Centuries—Experiments in consort touching Music**

Francis Bacon (1561–1626)

2.10 **1634: Shakkei (借景) & ikedori** (Borrowed scenery)

Ji Cheng (计成) (1582– ca. *1642)*

2.11 **1641: Mercury, or The Secret and Swift Messenger: shewing, how a man may with privacy and speed communicate his thoughts to a friend at any distance**

Bishop John Wilkins (1614–1672)

2.12 **1725: The Ocular Harpsichord** (Le clavecin pour les yeux)

2.12.1 Louis-Bertrand Castel (1688–1757)

Comment: "As the harmony and discord of sounds proceeded from the properties of the aerial vibrations, so may the harmony of certain colours, as of golden and blue, and the discord of others, as of red and blue, proceed from the properties of the aetherial. And possibly color may be distinguished into its principal degrees, Red, Orange, Green, Blew, Indigo and deep Violet on the same ground, that sound within an eighth is graduated into tones." (Isaac Newton, "Letter to the Royal Society, 1675", In "The Correspondence of Isaac Newton", ed. H.W. Turnbull et al., Vol. 1, p. 376, Cambridge: Cambridge University Press, 1959–1977).

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Translated excerpt: « […] Now it is analogy that renders these poetic flashes fecund in discoveries. Because what one calls among the poets and orators "metaphor, similitude, allegory, figure"; a philosopher, a geometer will call "analogy, proportion, ratio". All our discoveries, all our scientific truths, are only truths of ratio. And from there often the figurative sense degenerates into the proper sense and the figure into reality. » (Louis-Bertrand Castel, "Suite et seconde partie des nouvelles expériences d'optique et d'acoustique adressées à M. le Président de Montesquieu", In "Journal de Trévoux," August 1735, p. 1625; English translation cited in T. L. Hankins and R. J. Silverman. (1995). p. 80).

2.12.2 Attached references

G. Comanini. (1591[2001]). The Figino, or On the purpose of painting: art theory in the late Renaissance. Ann Doyle-Anderson et Giancarlo Maiorino (Eds and Trans.). Toronto: University of Toronto Press, 2001; N. Malebranche (1674). De la Recherche de la Vérité. Strasbourg: Chez George André d'Olhoff; Karl von Eckartshausen (1752–1803), Color Organ (1788); Bainbridge Bishop (?), The Color-Organ (1876); Alexander Wallace Rimington (1854–1918), Colour Organ (1915); Vladimir Baranoff Rossiné (1888–1944), Optophonic Piano (1916); Thomas Wilfred (Richard Edgar Løvstrom) (1889–1968), Clavilux—Lumia (1920); Arthur C. Vinageras (?), Chromopiano (1921); Alexander Laszlo (1895–1970), Farblichtmusik (1925).

2.12.3 Sources

L.B. Castel. (1725). Clavecin pour les yeux, avec l'art de peindre les sons, et toutes sortes de pièces de musique, Lettre écrite de Paris le 20 février 1725 par le R.P. Castel, Jésuite, à M. Decourt, à Amiens. Mercure de France, pp. 2552–2577; M. Franssen. (1991). The ocular harpsichord of Louis-Bertrand Castel: The science and aesthetics of an eighteenth-century cause célèbre. In "Tractrix (3): Yearbook for the History of Science, Medicine, Technology and Mathematics," pp. 15–77; T.L. Hankins and R.J. Silverman. (1995). Instruments and the Imagination. Princeton University Press (1999), pp. 72–85, and p. 247.

2.13 **1750: Die Kunst der Fuge BWV 1080** (The Art of Fugue)

2.13.1 Johann Sebastian Bach (1685–1750)

Comment: « Über dieser Fuge, wo der name B A C H im Contrasubject angebracht worden, ist der Verfasser ges-torben » (At the point where the composer introduces the name BACH [Ed.: for which the English notation would be Bb-A-C–B] in the countersubject to this fugue, the composer died). [Ed.: This note in the handwriting of Bach's son Carl Philipp Emmanuel Bach is written on the Contrapunctus XIV autograph. The use of motif or musical cryptogram (or "gematria", number-word symbolism) or musical signature or ciphered versions of names in musicians' compositions corresponds to a cryptogrammatic sequence of musical notes referred to an extra-musical text and logical system (between numbers, note names, and letters: syllables to solmization names, letters to note names, etc.). Composers have dabbled in musical cryptograms for centuries: Josquin des Prez; Adrian Willaert; Costanzo Festa; Johannes Brahms; Franz Liszt; Robert Schumann; Nikolai Rimsky-Korsakov; Max Reger; Ferruccio Busoni; Charles Koechlin; Camille Saint-Saëns; Gabriel Fauré; Arnold Schoenberg; Anton Webern; Maurice Ravel; Florent Schmitt; Charles Ives; Francis Poulenc; Albert Roussel; Arthur Honegger; Darius Milhaud; Hans Eisler; Olivier Messiaen; Dmitri Shostakovich; Edward Elgar; Elliot Carter; etc.].

2.13.2 Attached references

Bishop John Wilkins (1614–1672), Mercury, or The Secret and Swift Messenger: shewing, how a man may with privacy and speed communicate his thoughts to a friend at any distance (1641); Jean-François Sudre (1787–1862), Téléphonie (1827), Solresol (1838); Samuel (Finley Breese) Morse (1791–1872), Recording telegraph—Morse code (1843), The Sounder (1846); David Henry Keller (1880–1966), The Lost Language (1934); Clarence Barlow (1945-), Çoğluot-obüsişletmesi (1975–1979), Synthrumentation (1998).

2.13.3 Sources

J.G. Walther. (1732). Musicalisches Lexicon. Leipzig: W. Deer; E. Sams. (1980). Cryptography, musical. In Sadie Stanley (Ed.), "The New Grove Dictionary of music and musicians". Vol. 5. p. 80. Macmillan.

2.14 **1761: Inventum novum ex percussione thoracis humani ut signo abstrusos interni pectoris morbos detegendi** (A New Discovery that Enables the Physician from the Percussion of the Human Thorax to Detect the Diseases Hidden Within the Chest), Joseph Leopold Auenbrugger (von Auenbrugg) (1722-1809)

2.15 **1787: Musikalisches Würfelspiel, K 516f** (Musical dice game)

2.15.1 Wolfgang Amadeus Mozart (1756–1791)

Original excerpt: « Anleitung: Walzer oder Schleifer mit zwei Würfeln zu componieren, ohne Musikalisch zu seyn,

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noch von der Composition etwas zu verstehen. » [Instruction: To compose a waltz or a schleifer/landler with two dice, without being musically gifted, nor knowing anything about composition.] (W.A. Mozart, KV 294 d; quoted in "Zeitschrift für Musikwissenschaft," Volume 16, Breitkopf und Härtel, 1934).

2.15.2 Attached references

Johann Philipp Kirnberger's Der allezeit fertige Menuetten- une Polonoisen Komponist (Würfel-Menuet) (The Ever Ready Composer of Polonaises and Minuets) (1757 1st edition; revised 2nd 1783); Carl Philipp Emanuel Bach's Idea of composing a six-bar double counterpoint at the octave without knowing the rules (c. 1757); Joseph Haydn's Gioco Filarmonico (Philharmonic Joke or the Art of Composing an Infinite Number of Minuets Without the Least Knowledge of Counterpoint) (1790); Maximilian Stadler (Tables according to which one can toss off minuets and trios); de la Chevardiere (The Harmonic Top—A Tabular System whereby any person without the least knowledge of music may compose ten thousand different minuets in the most pleasing and correct manner); Christian Ernst Graf; Max Fiedler; Johann Caspar Ferdinand Fischer; Antonio Calegari (L'Art de composer de la musique sans en connaitre les elements, 1802); Dodecaphonism, Serialism, Algorithmic & Stochastic music, etc.

2.15.3 Sources

W.A. Mozart. (ca. 1787). Ms. 253 (K. Anh. 294d/516f). Bibliothèque Nationale, Paris (Collection Malherbe); W.A. Mozart. (ca. 1787). Musikalisches Wurfelspiel. Edited by Karl Heinz Taubert. Mainz: B. Schott's Söhne, 1956; S.C. Hedges. (1978). Dice Music in the Eighteenth Century. In "Music and Letters" (1978) Vol. 59 (2): 180–187. Oxford University Press; J. Hearon. (2005). Lexicon Musikautomaten: Die Welt der selbstspielenden Musikinstrumente (review). In "Computer Music Journal," Volume 29, Number 1, Spring 2005, pp. 100–101. Published by the MIT Press.

2.16 **1802: Auscultation**

Mathieu-François-Régis Buisson (1776–1804)

2.17 **1819: Stethoscope: On Mediate Auscultation**

2.17.1 René-Théophile-Marie-Hyacinthe Laënnec (1781–1826)

Comment: « Buisson distinguishes two sorts of hearing, the passive or "audition", the active or "auscultation", a division based on equally exact observations, and on which is based the difference between the words, "to hear" and "to listen" » (Laënnec on Buisson (1802), in "Journal de Médecine Brumaire;" quoted in Duffin, "To see with a better eye", p. 43; cited by Jonathan Sterne, In "The Audible Past", p. 100)—Laënnec introduced "auscultation" to appreciate the different sounds, which can be heard in the chest, and in the diagnosis of diseases of the heart, lungs, etc. This may be done by the aid of an instrument called a "stethoscope", one extremity of which is ap-plied to the ear, the other to the chest of the patient. This mode of examination is called "Mediate Auscultation", (F) Auscultation médiate—the application of the ear to the chest being "immediate auscultation". The act of exploring the chest is called "Stethoscopia", and "Thoracoscopia"; of the abdomen, "Abdominoscopia". (Robley Dunglison, p. 83, 1845).

2.17.2 Attached references

Mathieu-François-Régis Buisson (1776–1804), Auscultation (1802); E. Boyd. (1905). Ancient Systems of Accounting (ca. 3500 BC); René-Théophile-Marie-Hyacinthe Laënnec (1781–1826), On Mediate Auscultation (1819); Dr. Benjamin Ward Richardson (1828–1896), Sphygmophone (1879); Dxing (1920); Hans Berger (1873–1941), Sonification of brainwaves (1934); Alvin Lucier (1931–), Music for a Solo Performer (1965); David Rosenboom (1947–), Brainwave Music (1975), Piano Etude I (Alpha) (1971). Car mechanics, Listen to the engine, Mechanic's stethoscope; Listen to the code, Code Smell; Codesounding.

2.17.3 Sources

R. Dunglison. (1845). Medical lexicon: a dictionary of medical science: containing a concise account of the various subjects and terms, with the French and other synonymes, notices of climate, and of celebrated mineral waters, formulae for various officinal and empirical preparations, etc.,. Fifth edition. Philadelphia: Lea and Blanchard.; R.-T.-M.-H. Laënnec. (1819). Traité de l'auscultation médiate, ou Traité du diagnostic des maladies des poumons et du cœur, fondé principalement ur ce nouveau mode d'exploration. Paris: Chez J.A. Brosson & J.S. Chaudé, 1837; J. Sterne. (2003). The Audible Past—Cultural Origins of Sound Reproduction. Durham & London: Duke University Press.

2.18 **1825: Electrical Disturbances on Telegraph Lines**

Comment: It finds confirmation also in the fact, generally admitted by the inhabitants of the northern regions, that,

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when the auroræ appear low, a crackling is heard similar to that of the electric spark. […] M. Ramm, Inspector of Forests in Norway, wrote to M. Hansteen, in 1825, that he had heard the noise, which always coincided with the appearance of the luminous jets, when, being only 10 years old, he was crossing a meadow covered with snow and hoar-frost, near which no forests were in existence. […] Dr. Gisler adds, that he has frequently hear the noise of the aurora, and that it resembles that of a strong wind, or the hissing that certain chemical substances produce in the act of decomposition. (George B. Prescott, 1860).

2.18.1 Attached references

Carlo Matteuci (1811–1868), observations (1848); Thomas A. Watson (1854–1934), Static currents (1876).

2.18.2 Sources

G. B. Prescott. (1860). Electrical Disturbances on Telegraph Lines. In "HISTORY, THEORY, AND PRACTICE OF THE ELECTRIC TELEGRAPH". pp. 317–332. Boston: Ticknor and Fields, University Press, Cambridge; Alfred Angot. (1897). The Aurora Borealis. International Scientific Series, Vol. LXXVII. pp. 46–51. New York: D. Appleton & Co; J.R. Capron. (1879). Auroræ: their characters and spectra. E. & F.N. Spon.

2.19 **ca. 1830: Metal detector**

R.W. Fox (?)

2.20 **1837: The Production of Galvanic Music**

2.20.1 Charles Grafton Page (1812–1868)

Original excerpt: « The Production of Galvanic Music—[…] A long copper wire covered with cotton was wound tightly into a flat spiral. After making forty turns, the whole was firmly fixed by a smearing of common cement, and mounted vertically between two upright supports. The ends of the wire were then brought down into mercury cups, which were connected by copper wires with the cups on the battery, which was a single pair of zinc and lead plates, excited by sulphate of copper. When one of the connecting wires was lifted from its cup a bright spark and loud snap were produced. When one or both poles of a large horse shoe magnet, are brought by the side or put astride the spiral, but not touching it, a distinct ringing is heard in the magnet, as often as the battery connexion with the spiral is made or broken by one of the wires. Thinking that the ringing sound might be produced by agitation or reverberation from the snap, I had the battery contact broken in a cup, at considerable distance from the field of experiment; the effect was the same as before. The ringing is heard both when the contact is made and broken; when the contact is made, the sound emitted is very feeble; when broken it may be heard at two or three feet distance. […] In each of these trials the sounds produced differed from each other; and were the notes or pitches peculiar to the several magnets. If a large magnet supported by the bend be struck with the knuckle, it gives a musical note; if it be slightly tapped with the finger nail, it returns two sounds, one, its proper musical pitch, and another an octave above this, which last is the note given in the experiment. » (C.G. Page, 1837).

2.20.2 Attached references

Mr. Pétrina (?), The Electric Harmonica (1856); William Du Bois Duddell (1869–1942), The Singing Arc (1899); Thaddeus Cahill (1867–1934), Telharmonium (1897); Second Telharmonium (1906); Lee de Forest (1873–1961), Audion Piano (1915); Lev Sergueïevich Termen (Лев Сергеевич Термен) (Leon Theremin) (1896–1993), Theremin (1919), Tersipchore (1932); Maurice Martenot (1898–1980), Ondes Martenot (1928); Edouard Eloi Coupleux (?) & Joseph Armand Givelet (?), Automatically Operating Musical Instrument of the Electric Oscillation Type (1929); Adolf Trautwein (1888–1956), Oskar Sala (1910–2002), Trautonium (1930); Wolja Saraga (1908–1980), Saraga-Generator (1931); A. Lesti (?) & F. Sammis (?), Radio Organ of a Trillion Tones (1931); John Cage (1912–1992), The Future of Music: Credo (1937); Carlos Chávez (1899–1978), Toward a New Music: Music and Electricity (1937).

2.20.3 Source:

C.G. Page. (1837). The Production of Galvanic Music. In "The American journal of science and arts." Conduc-ted by Benjamin Silliman. Volume 32, July 1837, pp. 306–307. New Haven: Hamlen.

2.21 **1855: The Calliope**

Joshua C. Stoddard (1814–1902)

2.22 **1856: The Electric Harmonica**

Mr. Pétrina (?)

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2.23 1876: Static currents

2.23.1 Thomas A. Watson (1854–1934)

Original excerpt: « There were no trolley car or electric light systems to send their rattling current-noises into our wire and the only other electric circuits in constant use were the telegraph wires, the currents in which, being comparatively weak and easily recognised as the dots and dashes of the Morse code, did not trouble us. This early silence in a telephone circuit gave an opportunity for listening to stray electric currents that cannot be easily had today. I used to spend hours at night in the laboratory listening to the many strange noises in the telephone and speculating as to their cause. One of the most common sounds was a snap, followed by a grating sound that lasted 2 or 3 s before it faded into silence, and another was like the chirping of a bird. My theory at this time was that the currents causing these sounds came from explosions on the sun or that they were signals from another planet. They were mystic enough to suggest the latter explanation but I never detected any regularity in tem that might indicate they were intelligent signals. They were seldom loud enough to interfere with the use of the telephone on a short line. A few years later these delicate sounds could no longer be heard for they were completely drowned out when electric light and power dynamos began to operate. I don't believe any one has ever studied these noises on a grounded telephone line since that time, for they could not be so studied today unless a wire were run in some wilderness far from electric light or power station. These currents were probably from the same source as the static that afflicts the modern radio, and the difference in sound may have been due to the fact they were not amplified in the telephone as static is now in a radio receiver. I, perhaps may claim to be the first person who ever listened to static currents. » (Thomas A. Watson, 1926).

2.23.2 Attached references

Heraclitus of Ephesus (ca. 544–541 BC—ca. 480 BC), Oracle, Sybil, Pythia (ca. 500 BC); Virgil (Publius Vergilius Maro) (70–19 BC), Aenis—Oracle in Delos (-29 BC); Pliny The Elder (23–79), The tingling of ears—Paracusia (ca. 77 AD); Plutarch of Delphi (ca. 46–120 AD), De Pythiae Oraculis (ca. 100AD); Leo the Mathematician (866–912), Automatons (ca. 900); Abbé Nollet (1700–1770), Ventriloquism (ca. 1750); Wolfgang von Kempelen (1734–1804), Sprachmachine (Speaking machine) (1769); Abbé C. Braun (?), Acousmate (1784); Mr. Charles (?), The Invisible Girl (1803); Professor Joseph Faber (?), Euphonia (1846); Guillaume Apollinaire (Wilhelm Albert Włodzimierz Apolinary de Wąż-Kostrowicki) (1880–1918), Acousmate (1899); Gaëtan Gatian de Clérambault (1872–1934), Vaticinations (1920); Dxing (1920); Sigmund Freud (1856–1939), Traum und Telepathie (Dreams and Telepathy) (1922); Upton Sinclair (1878–1968), Mental radio (1930); Alvin Lucier (1931–), Sferics (1981).

2.23.3 Source

T.A. Watson. (1926). Exploring Life: The Autobiography of Thomas A. Watson. Chapter IX, pp. 81–82. New York & London: D. Appleton & Co.

2.24 1878: D'Arsonval galvanometer & galvanoscope

Jacques Arsène d'Arsonval (1851–1940).

2.25 1879: Note on the Invention of a Method for Making the Movements of the Pulse Audible by the Telephone. The Sphygmophone

Dr. Benjamin Ward Richardson (1828–1896)

2.26 1882: Suggestion of electromagnetic radiations sonification

Léon Voirin (1833–1888)

2.27 1881: Electric ore finder

Comment: "About the electrical ore finder—A current of electricity passing through a coil is made to enter the ground at one point in the property, and passes through the earth to another point where a telephone receiver allows observer to estimate the different intensity of sound made by the make and break in the circuit. The sound becomes louder under certain conditions of reef and mineral contents underground, but it is almost impossible to say whether the change in any particular instance is due to a fairly high percentage of iron pyrites or a small amount of gold, which gives practically the same result with the finder." (In "Thames Star", Volume XXXXI, Issue 10687, 16 August 1904, p. 1).

2.27.1 Attached references

R. W. Fox (?), Metal detector (ca. 1830); Joseph Henry (1797–1878) & Michael Faraday (1791–1867), theory of electromagnetism (1831); Heinrich Wilhem Dove (1803–1879), earliest form of induction balance (1841);

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Alexander Graham Bell (1847–1922), experiments in induction balance with the telephone (1877); Prof. David E. Hughes (1831–1900) & William Groves (?), Induction Balance (I.B.) as a metal locator (1879); George Hopkins (?), Hopkins electric ore finder (1881); Dr. John Girner (?), experimentation with locating metallic masses in the human body (1887); Captain McEvoy (?), electric submarine detector (1883 & ca. 1905); London Electric Ore Finding Company Ltd, Bristish patent of a metal detector (1902); Electric Metal Locating Company of Chicago (and Fred H. Brown (?)), metal detection (?); Daniel Chilson (?), electromagnetic radio-detector (1924); George Williams (?), Radio-Locator (ca. 1925); Gerhard Fisher (?), Metalloscope (1929); Theodore Theodorsen (1897–1978), instrument for detecting metallic bodies buried in the earth: N.A.C.A Bomb Detector (1930); George Maher (?), Alpha (?); Engineering Research Corporation, Terrasearch (?); Goldak Inc., Radioscope (ca. 1939); J. Evan-Hart & D. Stuckey (?), Detectorist (2007).

2.28 **1899: The Singing Arc**

2.28.1 William Du Bois Duddell (1869–1942)

Comment: Prior to the invention of the incandescent light bulb, arc lamps were used to light the streets. They created light by means of an electrical arc between two carbon electrodes. These lamps also produced a constant audible hum. Duddell was appointed in 1899 to solve this problem. As a result of his research (through which he demonstrated the humming was caused by a fluctuating electric current), he invented the singing arc, which could generate musical notes by way of a keyboard which interrupted oscillations in a circuit, making it one of the first examples of electronic music, and the very first that did not use the telephone system as an amplifier or speaker. When Duddell exhibited the singing arc to the London Institution of Electrical Engineers, arc lamps on the same circuit in other buildings were noticed to play the tones of Duddell's machine [Ed.: by generation of frequencies up to about 1MHz]. Despite the potential of music delivered over the lighting network, Duddell did not capitalize on his discovery as anything more than a novelty. (Comment under Creative Commons CC-BY-SA license, In Wikipedia: The Free Encyclopedia. Wikimedia Foundation. Retrieved November 4, 2010).

2.28.2 Sources

G.L. Frost. (2010). Early FM Radio: Incremental Technology in Twentieth-Century America. pp. 24–25. Baltimore: The John Hopkins University Press; M. Babbitt. (1960). The Revolution in Sound: Electronic Music. In "Columbia university Magazine," (Spring 1960): 4–8; and also: In "Music Journal" 18, n° 7 (1965). pp. 34–35; and also: In "The Collected Essays of Milton Babbitt." Edited by Stephen Peles with Stephen Dembski, Andrew Mead, & Joseph N. Straus. p. 76. Princeton: Princeton University Press, 2003.

2.29 **1900**: **Die Erweiterung unserer Sinne** (The Extension of our Senses)

Otto Wiener (1862–1927)

2.30 **1912: Optophone**

2.30.1 Edmund Edward Fournier d'Albe (1868–?)

Comment: Edmund Edward Fournier d'Albe […], Physicist, appointed Assistant-Lecturer in Physics at Birmingham University in 1910 where he did research on the electro-optical properties of selenium—the "reading optophone" used a vertical arrangement of five light sources and detectors that was scanned across printed characters, each detector corresponded to a note on the musical stave with the amplitude indicating the amount of reflected light. […] (In "MANNIN: a Journal of Matters Past and Present relating to Mann (Isle of Man)." Vol. II, n° 1. November 1914. Notes, p. 248. Published by Yn Cheshaght Gailckagh, the Manx Language Society. Editor: Miss Sophia Morrison. Printer: L. G. Meyer, Douglas. May, 1913, to May, 1917).

2.30.2 Attached references

Fay Cluff Brown (1881–1968), Phonopticon (ca. 1912).

2.31 **ca. 1914**: **The Gamage Ltd Sound Locator No1 Mk1** *manufactured by A.W. Gamage Ltd.*

2.32 **1919: Ur-Geräusch** (Primal sound)

2.32.1 Rainer Maria Rilke (1875–1926)

Translated excerpt: « […] The coronal suture of the skull (this would first have to be investigated) has –let us assume– a certain similarity to the closely wavy line which the needle of a phonograph engraves on the receiving, rotating cylinder of the apparatus. What if one changed the needle and directed it on its return journey along a tracing which was not derived from the graphic translation of a sound, but existed of itself naturally – well: to put it plainly, along the coronal suture, for

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example. What would happen? A sound would necessarily result, a series of sounds, music … Feelings—which ? […] The achievements of the microscope, of the telescope, and of so many devices which increase the range of the senses upwards and downwards, do they not lie in another sphere altogether, since most of the increase thus achieved cannot be interpenetrated by the senses, cannot be "experienced" in any real sense ? It is, perhaps, not premature to suppose that the artist, who develops the five-fingered hand of his senses (if one may put it so) to ever more active and more spiritual capacity, contributes more decisively than anyone else to an extension of the several sense fields, only the achievement which gives proof of this does not permit of his entering his personal extension of territory in the general map before us, since it is only possible, in the last resort, by a miracle. […] » (Rainer Maria Rilke, 1919; Trans. by Carl Niemeyer).

2.32.2 Attached references

Jean-Marie Guyau (1854–1888), La Mémoire et le Phonographe. In Revue philosophique de France et de l'étranger, Paris, pp. 317–322, cinquième année, Tome IX, janvier à juillet 1880.

2.32.3 Source:

R.M. Rilke. (1919). Primal Sound & Other Prose Pieces. Trans. by Carl Niemeyer. Massachusetts: Cummington Press, 1943.

2.33 **1922: Optophonetics**

2.33.1 Raoul Hausmann (1886–1971)

Comment: « I wanted to draw your attention to the fact that I developed the theory of the Optophone, a device for transforming visible forms into sounds and vice versa, back in 1922. » (Raoul Haussmann, In a letter to Henri Chopin dated 23 June 1963)—« With the appropriate technical equipment the Optophone can give every optical phenomenon its sound equivalent, in other words, it can transform the difference in the frequencies of light and sound. » (Raoul Hausmann, 1922).

2.33.2 Attached references

László Moholy-Nagy (1895–1946), Production—Reproduction (in "De Stijl") (1922); Abram Room (1894–1976), Piatiletka. Plan Vélikih Rabot (Plan of Great Works) (1929); Evgeny Sholpo (Е.А.Шолпо) (1891–1951), Variophone (1930); Nikolai Voinov (1900–1958), Nivotone (1931); Oskar Fischinger (1900–1967), Tönende Ornamente (Sound Ornaments) (1932), Tönende ABC (1933), Lumigraph (1950); Erkki Kurenniemi (1941-), DIMI-O (1970); David Behrman & Bob Diamond & Robert Watts, Cloud Music (1974); Yasunao Tone (1935–), Voice and Phenomena (1976).

2.33.3 Sources

R. Hausmann. (1922). Optophonetika. In "Vehsch"-Gegenstand-Object' 3, May 1922; J. Donguy. (2001). Machine Head. Raoul Hausmann and the Optophone. In "Leonardo—Journal of the International Society for the Arts, Sciences and Technology" 34, Number 3, June 2001, pp. 217–220. MIT Press.

2.34 **1929: Three Places in New England (Orchestral Set No. 1)**

2.34.1 Charles Ives (1874–1954)

Comment: Each of the three movements is named for a place in New England, USA. Each is carefully composed to make the listener feel as though he or she is at that very place, experiencing its unique atmosphere. Ives' use of paraphrasing American folk tunes is particularly important in creating such an effect, as it provides the listener with some sort of tangible reference point from which to access the music. (Comment under Creative Commons CC-BY-SA license, In Wikipedia: The Free Encyclopedia. Wikimedia Foundation. Retrieved November 4, 2010).

2.34.2 Attached references

Walter Benjamin (1892–1940), Die Wiederkehr des Flaneurs (The Return of the Flâneur) (1929); Henri Bergson (1859–1941), La pensée et le mouvant (The Creative Mind) (1934); Gaston Bachelard (1884–1962), L'intuition de l'Instant (1934), Droit et Rêverie, Logosphere (1951), La Poétique de l'Espace (The Poetics of Space) (1958), La Poétique de la Rêverie (1960); Heitor Villa-Lobos (1887–1959), New York Skyline (1939), Symphony n°6: On the Profiles of the Mountains of Brazil (1944); Pierre Teilhard de Chardin (1881–1955), Noosphere (1955); Guy-Ernest Debord (1931–1994), Psychogeography & Theory of the Dérive (1956); John Cage (1912–1992), Atlas Eclipticalis (1961–1962), Etudes Australes (1974–1975), Etudes Boreales (1978); Charles Dodge (1942-), Earth's Magnetic Field (1970); Henri Lefevre (1901–1991), La Production de l'Espace (The Production of Space) (1974); Michel de

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Certeau (1935–1986), L'Invention du Quotidien (The Practice of Everyday Life) (1980).

2.34.3 Source

B.G. Tiranny. (2003). Out To The Stars, Into The Heart: Spatial Movement in Recent and Earlier Music—Antiphonal Space. In "NewMusicBox," the Web magazine from American Music Center, published: January 1, 2003.

2.35 **1933: La Radia—Manifesto futurista della Radio,** La Gazetta del Popolo, 22 settembre 1933

2.35.1 Filippo Tommaso Marinetti (1876–1944), Pino Masnata (1901–1968)

Translated excerpt: « […] 3. The immensification of space. No longer visible and framable the stage becomes universal and cosmic. […] 7. An art without time or space without yesterday or tomorrow. The possibility of receiving broadcast stations situated in various time zones and the lack of light will destroy the hours of the day and night. The reception and amplification of the light and the voices of the past with thermoionic valves will destroy time. 8. The synthesis of infinite simultaneous actions. […] 11. Struggles of noises and of various distances that is spatial drama joined with temporal drama. […] » (Translated by Stephen Sartarelli in Kahn, D. and Whitehead, G. (ed.), Wireless Imagination. Sound, radio and the Avant-garde, The MIT Press, Cambridge, Massachusetts/London, England, 1992, pp. 265–268).

2.36 **1934: Art As Experience**

2.36.1 John Dewey (1859–1952)

Original excerpt: « […] Music, having sound as its medium, thus necessarily expresses in a concentrated way the shocks and instabilities, the conflicts and resolutions, that are the dramatic changes enacted upon the more enduring background of nature and human life. The tension and the struggle has its gatherings of energy, its discharges, its attacks and defenses, its mighty warrings and its peaceful meetings, its resistances and resolutions, and out of these things music weaves its web. […] The eye is the sense of distance—not just that light comes from afar, but that through vision we are connected with what is distant and thus forewarned of what is to come. Vision gives the spread-out scene—that "in" and "on" which, as I have said, change takes place. […] Sound stimulates directly to immediate change because it reports a change. […] Sound is the conveyor of what impends, of what is happening as an indication of what is likely to happen. It is fraught much more than vision with the sense of issues; about the impending there is always an aura of indeterminateness and uncertainty—all conditions favorable to intense emotional stir. […] » (John Dewey, pp. 245–246).

2.36.2 Sources

J. Dewey. (1934). Art as Experience. Rahway, NJ: The Barnes Foundation Press; New York: Perigee Books, 1980; and also, New York: The Berkeley Publishing Group, Perigee, The Penguin Books, 2005.

2.37 **1939: Music as an Art-Science**

2.37.1 Edgard (Edgar) Varèse (1883–1965)

Original excerpt: « At different times and in different places music has been considered either as an Art or as a Science. In reality music partakes of both. H. Wronsky and Camille Durutte (H. Wronsky (1778–1853), also known as Joseph Marie Wronsky, was a Polish philosopher and mathematician, known for his system of Messianism. Camille Durutte (1803–1881), in his "Technique Harmonique" (1876), a treatise on "musical mathematics," quoted extensively from the writings of Wronsky), in their treatise on harmony in the middle of the last century, were obliged to coin new words when they assigned music its place as an "Art-Science," and defined it as "the corporealization of the intelligence that is in sounds." Most people rather think of music solely as an art. But when you listen to music do you ever stop to realize that you are being subjected to a physical phenomenon ? […] Preceding ages show us that changes in art occur because societies and artists have new needs. New aspirations emanate from every epoch. The artist, being always of his own time, is influenced by it and, in turn, is an influence. […] Yet science is even now equipped to give them everything they may require. Personally, for my conceptions, I need an entirely new medium of expression: a sound-producing machine (not a sound-reproducing one). Today it is possible to build such a machine with only a certain amount of added research. […] (From a lecture given at the University of Southern California, 1939).

2.37.2 Sources

E. Varèse. (1939). Music as an Art-Science. In Bennington college Alamnae Quaterly, vol. VII, n°I, 1955; J.-C. Risset. (2004). The liberation of sound, art-science and the digital domain: contacts with Edgard Varèse. In "Contemporary Music Review," Volume 23, Issue 2 June 2004, pages 27–54.

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References

Joy J (2003–2005, 2010). Télémusique—organologie de la musique en réseau. (Part of a PhD research), Retrieved October 30, 2010, from http://www.fr.wikipedia.org/wiki/Musique_en_réseau

Joy J (2009) Une Époque Circuitée. Paper presented at Metamedia Symposium, Mois Multi, Avatar Québec, 2007

Joy J (2009) Networked music & soundart timeline (NMSAT) excerpts of part one: ancient and modern history, anticipatory literature, and technical developments references. par Jérôme Joy, In revue Contemporary Music Review, "Network Performance", vol. 28, Nos 4/5, p. 449–490, Taylor & Francis Group, Oxford, 2009

Joy J (2010) Une Époque Circuitée—Réflexion sur l'organologie des arts en réseau: le passage de l'Internet à un état musical. In Revue Intermédialités—April, 2010, No. 13—Programmer, pp 57–76, CRI Université de Montréal (QC), 2010

Joy J (2010) La Musique Étendue—« En Plein Air » (Extended Music—Out in the Open). In: Yang Yeung (ed) Around, catalog of the sound festival, Soundpocket, Hong Kong (HK), 2010

Joy J, Sinclair P (2008) Les Espaces Sonores en Réseau (Networked Sonic Spaces). In: GlobalWare Corporation (ed) Roots/Routes, International Computer Music Conference ICMC'08 (Panel: Networking Performance) (pp. 553–555). Belfast: SARC, Sonic Art Research Center, Queens University, & International Computer Music Association ICMA (Publishers)

Joy J, Sinclair P (2009) Networked music & soundart timeline (NMSAT): a panoramic view of practices and techniques related to sound transmission and distance listening. In: Contemporary music review, "Network Performance", vol 28, Nos 4/5, pp 351–361, Taylor & Francis Group, Oxford

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