10 Experimenting with Media Temporality

Pythagoras, Hertz, Turing

All such mass media as the phonograph, kinematograph, radio, and electronic television were first developed for experimental research. Media are measuring devices, and as such they are scientific, analytical apparatuses. To put it roughly, any listening to music on records or to radio programs is essentially experimental, a kind of reverse experimentation. The well-known television tube was developed out of a measuring device, Ferdinand Braun's electronic oscilloscope, just as the Edison phonograph was preceded by Léon Scott's Phonautograph, created to register the frequencies of the human voice for analytic purposes. Tuning an analog radio is experimenting with radio waves and their electromagnetic resonances. The public-use "synthetic" mass media represent a step from such measuring devices to worlds of mass media, as we often approach them, but we are able to also analytically approach the *reverse experience:* to go back to the scientific experimentality of such machines.

The subject of "experimentality as event" touches a crucial figure of contemporary epistemology, especially when we take epistemology in its processual, time-based sense as defined by cybernetics. This comes from its self-definition and the insight into "circular causal and feedback mechanisms in biological and social systems."[1] Heinz von Foerster is explicit when he states that epistemology is not meant as a static theory of knowledge.[2] In analytic philosophy (as represented by Alfred North Whitehead), the "event" represents an ontological being that is not a static object but a process. Such a processual ontology is close to the essence of media technologies itself (because only when in operation is a medium in its medium state). Media archaeology uncovers not artifacts but events, which is where it differs from the traditional archaeological discipline.

So let us investigate the processuality and event nature of media-enhanced experimentation. One level of temporality is the microtemporal behavior of the object in question (that is, "under experiment"); the second is what it does to (or with) the "temporal sense" of the human experimenter. An ambivalent experience of experimental time takes place in three exemplary scenarios: first, the insights into the mathematical beauty of cosmic relations that Pythagoras experienced when he pulled the string of his monochord in early Greek antiquity; second, the microtemporal nature of electromagnetic oscillations (Heinrich Hertz's "radio" experiment); and third, Alan Turing's notion of a computing mechanism that strictly exists in discrete "states." On the one hand, such experimental settings clearly belong to what we call and describe as cultural history (or the "history of knowledge," in more Latourean terms), but on the other hand (from the point of view of the media themselves, and hence the media-archaeological perspective), there is something *at work* (at the level of both the artifact and the epistemological *dispositif*) that is indifferent to the historical. This I call the "time-invariant event."

"Experiment as event" can be reformulated as "experiencing the event." The media-archaeological view considers the question of how media temporality, and especially its proper temporal figure of time-critical and microtemporal processes, is experienced through the experiment. In contrast to empirical experience of the observation of primary nature, media-experimental settings perform "culturalized" experiences of a secondary nature—with measuring media the crucial observers. A media-experimental setting is an artificial configuration based on cultural knowledge—but it is still of a physical nature because there are electro- or even quantum-physical laws at work that are not solely dependent on the respective cultural discourse. The media-experimental event cannot be reduced to discursive effects. There is always the imminent "veto" that comes from physics.

Listening to the Monochord (Pythagoras versus Mersenne)

If we reenact today the procedure by which Pythagoras experimented with the monochord in the sixth century BC, pulling such a string, we actually reenact the technophysical insight of the relation between integer numbers and harmonic musical intervals that once led Greek philosophers to muse about the mathematical beauty of cosmic order in general.[3] We are certainly not in the same historical situation as Pythagoras, because our circumstances, even our ways of listening and the psychophysical tuning of our ears, are different. But still the monochord is a time machine in a different sense: it lets us share, participate in, the original discovery of musicological knowledge because—in an almost Derridean sense (expressed in his *Grammatology*)—the repeatable *is* the original.[4] On the one hand, in phenomenology the event is a singular and instant act that cannot be subsumed under general terms. On the other hand, in Martin Heidegger's late philosophical work, the fundamental notions of being *(Sein)* and time *(Zeit)* converged in the notion of the event *(Ereignis)*.[5] In this double sense, the experiment allows a unique experience for communication across the temporal gap. It bridges a temporal distance. In the processual moment of the reenacted experiment, we share the same temporal *field* as the past time (a notion that implicitly refers to the episteme of electromagnetic induction).

So far experimentation has been applied to the analysis of microtemporal events. Can experimentation be extended to the macrotemporal event as well? At first glance, experimentation does not give access to historic knowledge because past events cannot be experimentally reenacted except perhaps in experimental archaeology. This is the argument historians usually applied to differentiate their hermeneutic discipline from the natural sciences.[6]

But media-archaeological experimentation (as opposed to historiographical historicism) gives access to the invariants of knowledge in time. One could in this way talk about "experiments with history" that extend practices of simulation to history. Such techniques are able to tunnel new connections through history, and this is where media archaeology finds its own ground as reenacting historical time objects, as Martin Carlé shows.[7] Such tunneling brings us back to Pythagoras's monochord and ancient music.

Radio and Light Waves (Heinrich Hertz)

The media-electronic equivalent to the vibrations of the monochord string is, of course, the electromagnetic wave. Sound and vision as experienced by television have their media-archaeological roots in early experiments on the nature of communication by electricity.[8] Radio waves, on the microtemporal level (that is, before becoming part of a mass medium called radio), have a sense of ending. Michael Faraday and Heinrich Hertz discovered that the relation between electricity and magnetism is not static but dynamic—which transformed the philosophical question of its essence into its perception as event:

1. Electric charges make electric fields.
2. Moving electric charges make magnetic fields.
3. A changing electric field makes a magnetic field.
4. A changing magnetic field makes an electric field.

We are faced here with microevents. A moving magnetic field induces a current in a conductor; reversed, a current generates a magnetic field. It was this finality, which is the temporality implicit in the event named induction, that led to a rupture with Newton's mechanistic notion of *actio in distans* and to early speculations on the common nature of light-wave propagation and electromagnetic oscillation. The theory of visible light as a specific part of the electromagnetic wave spectrum was synthesized by James Maxwell. Maxwell symbolically analyzed the event nature of electric and magnetic fields as inductively found by Faraday's experiments.

Maxwell composed four mathematical formulas summarizing these phenomena, finally combining them into one that had the same form as the equation all waves obey. Thus he demonstrated that it was the electric and magnetic fields that were oscillating in light. The speed of these oscillations (the proverbial "speed of light") was predicted by Maxwell's work.

In 1887 Heinrich Hertz produced ultrafrequent electromagnetic waves and detected them at the other end of his experimental setting in his extended lab (in fact, a university auditorium). The Kantian notion of space itself here became critical: successively, experimentation has not taken place exclusively in macro-Newtonian space but has explored "electromagnetic space."[9] The measuring media, though, still belong to the macrophysical word.

Through his experimental setting, in 1886 Hertz demonstrated that sparks are in fact ultrafrequent oscillations of electricity and transmit electromagnetic waves that behave as light. Such sparks have been known since the discovery that rubbing pieces of amber together led to the emission of sparks (this is why electricity has been named after the Greek *elektron* since Thales of Miletus).

These sparks already behaved like "radio," but there was a detector missing, both mentally (humans) and technically (there was no "detector" until Édouard Branly's "coherer," invented in 1890 as a laboratory device in the Parisian Salpêtrière and further developed by Oliver Lodge). Radio thus was unconsciously invented in the laboratory (and only later put together by entrepreneurs like Guglielmo Marconi, who combined the Hertzean apparatus with Branly's device and Popov's antenna to make a functional tool for transmitting wireless Morse code). The experimental system "knew" it already. With a slight variation of an expression coined by Douglas Kahn, we might say that radio discovered itself before it was invented.[10] This alreadyness is the index of a nonhistorical temporality that is equally original each time in experimentation.

Experimenting with electromagnetic wave propagation has not merely been the prehistory of the mass medium called radio but is the alternative approach to it. When Hertz discovered that electromagnetic waves propagate by means of the high-frequency excitation of an open oscillating circuit, it was the result of an experimental query.

In 1901, communication bridged the Atlantic using electromagnetic waves for the transport of informative signals. But "wireless" has not always been synonymous with "radio" as a medium of communication. The patent registered in 1904 by John Ambrose Fleming developed an effect detected by Edison in experimenting with lightbulbs by which electricity can flow from filaments to an additional enclosed electrode even if there is no direct contact. In his patent manuscript of 1884, "A Manifestation of the Edison Lamp," Edison explicitly describes electricity flowing through the vacuum "without wires," literally wireless: radio inside the evacuated, etherless tube itself.

Let us thus solve the riddle of why Heinrich Hertz had not already considered the implied radio content of his experiments. Early radio was closer to Morse code than to what we know as radio today, or, to put it differently, it was literally digital before it became, through speech and music modulation, an analog medium. The digital managed its reentry only through pulse code modulation, through which radio, in fact, finds its way back to its original potential as a telegraphic medium.

Computing as Experimentation (Turing)

Pulse and counting bring us to an alternative kind of experimental time, which is an extreme of what the vibrating media have been considered before: discreet microevents called "digital." Alan Turing's notion of a computing mechanism, which started as a thought experiment, was based on the unconditional assumption that this machine could exist only in discrete "states." Experimental media eventuality changed from the continuous (the electromagnetic radio paradigm) to the discrete. The Turing machine experimented with the eventuality of mathematics. And yet computing extends to both analog and digital.

James Clerk Maxwell's differential equations have been the symbolical tools used to master the phenomenon of what Michael Faraday called the "field," that is, the sphere of electromagnetic interaction and induction. Thus mathematics itself is the simulation of a physical event with symbolical means (operators). Experimentation by computing is usually associated with the digital computer, in which the mathematical algorithm is a model of the physical event to be simulated. However, simulation by analog computers performs mathematical simulation by (electro-)physical means itself; the setting and configuration comprise a "physical experiment" in themselves.[11]

In analog computing, material elements that embody certain mathematical structures such as integration and multiplication are coupled according to a mathematical model analogous to the simulated object. Analog machinery is not a metaphysical, intransitive abstraction from the world (a "language") but part of physics itself. In analog computing, mathematics becomes experimentation itself. Analog computing is experimentation, which means in this context doing mathematics in the engineering way. Thus the analog computer is less a mathematical machine than "a model for experimentation"[12] whose virtue is real-time performance and thus providing an intuitive interface, a temporal sense of the objects under analysis.

This analogization is not exclusively based on a construction of cultural knowledge but rather on an implicit knowledge in nature itself. Again and again scientists have been amazed by the analogous behavior of a swinging

The Bulle Electric Pendulum Clock, one form that exemplifies the intertwining of time and technology. From the Media Archaeological Fundus. Photograph courtesy of Sebastian Döring and the Institute for Musicology and Media Studies, Humboldt University, Berlin.

pendulum (a mass, suspended at a lever), an electronic short-circuiting of induction (coil) and capacity (condensers).[13] The syllogistic medium of both mechanical and electrical operations is a mathematical differential equation common to both. According to an operating manual for one analog computer, "One of the most powerful applications of analog computers is simulation in which physical properties, not easily varied, are represented by voltages which are easily varied."[14] Simulation generally means performing experiments on a model in order to gain insights into the physically real, modeled system; such modeling by computers step-by-step replaces the traditional physical experiment.[15] The analog computer can even be functionally integrated into the analyzed system (such as the simulation of a nuclear reactor by analog computing); there is no longer the problem of the distance of the observer but rather there is immersive experimentation.

Experimentation by numbers (digital computing) differs from analog by introducing virtual, that is, mathematized, counted time, experimenting with virtualities in simulation. This virtuality also refers to time-axis manipulation, which cannot be done with physical means, thus engendering knowledge,[16] chronomorphing experimental events or even creating "events" that otherwise have not been perceptible to human senses. The implication is that the digital simulation of experiments can lead to the creation of a new type of events: artificial events, "artifactual events," revealing not physical but mathematical moments of the real. As Eric Winsberg writes: "All discretization techniques present the possibility of roundoff errors or instabilities creating undetected artifacts in results."[17]

Numerical experiments are simulations performed by the digital computer, in other words, operative diagrams. In between the physical laboratory experiment on the one hand and theoretical physics on the other, such simulations realize a true media theory, that is, theoretical reasoning is being algorithmically implemented in the real world (as the computer has been born out of a theoretical mathematics, the *Entscheidungsproblem,* articulated by Alan Turing in 1936). Being in the world, that is, being in time and thus happening as events, complex models can result in phenomena that have not been envisioned by the author of the program, thus generating unexpected phenomena. Such phenomena are information in the true sense of mathematically informed communication theory.[18]

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1. The original title of the Macy Conferences in New York, which resulted in the publication of Heinz von Foerster, ed., *Cybernetics: Transactions of the Sixth Conference* (New York: Josiah Macy Jr. Foundation, 1949), and subsequent volumes by Heinz von Foerster, Margaret Mead, and Hans Lukas Teuber (1950, 1951, 1953, 1955).

2. Heinz von Foerster, *Sicht und Einsicht: Versuche zu einer operativen Erkenntnistheorie,* autorisierte dt. Fassung v. Wolfram K. Köck (Braunschweig, Germany: Vieweg, 1985), 65 (a summary of the chapter "Kybernetik einer Erkenntnistheorie").

3. This includes the rejected experience and fear of deviation of this aesthetic ideology resulting in the "Pythagorean *komma,*" that is, irrational number relations.

4. Martin Heidegger, *Sein und Zeit,* 17th ed. (Tübingen: Max Niemeyer, 1993), 385. "Die *Wiederholung ist die ausdrückliche Überlieferung,* das heißt der Rückgang in die Möglichkeiten des dagewesenen Daseins." Italics in original.

5. See Martin Heidegger, *Beiträge zur Philosophie (Vom Ereignis),* 3rd ed., Gesamtausgabe III. Abt. *Unveröffentliche Abhandlungen Vorträge—Gedachtes,* Band 65 (Frankfurt am Main: Klostermann, 2003).

6. Hermann von Helmholtz declares at the climax of historicism in Germany: "Die Beziehung auf die Geschichte der Musik wird . . . auch deshalb nötig, weil wir hier Beobachtung und Experiment zur Feststellung der von uns aufgestellten Erklärungen meist nicht anwenden können, denn wir können uns, erzogen in der modernen Musik, nicht vollständig zurückversetzen in den Zustand unserer Vorfahren, die das . . . erst zu suchen hatten." Hermann von Helmholtz, *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik* (Brunswick, Germany: Vieweg 1913), 411.

7. Martin Carlé, "Geschenke der Musen im Streit ihrer Gehörigkeit: Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft," *Musiktheorie: Zeitschrift für Musikwissenschaft,* vol. 4, *Zur Aktualität des antiken griechischen Wissens von der Musik* (2007): 313–14.

8. See Wolfgang Hagen, "Technische Medien und Experimente der Physik: Skizzen zu einer medialen Genealogie der Elektrizität," in *Kommunikation, Medien, Macht,* ed. Rudolf Maresch and Niels Werber (Frankfurt am Main: Suhrkamp, 1998), 133–73, available online at www.whagen.de.

9. See Johannes Gfeller, "Der Referenzgerätepool von *AktiveArchive* an der Hochschule der Künste Bern," in *Schweizer Videokunst der 1970er und 1980er Jahre: Eine Rekonstruktion,* ed. Irene Schubiger (Zürich: Ringier, 2009), 215.

10. See Douglas Kahn, "Radio Was Discovered before It Was Invented," in *RELATING RADIO: Communities, Aesthetics, Access; Beiträge zur Zukunft des Radios,* ed. Golo Föllmer and Sven Thiermann (Leipzig: Spector, 2006), 24–32.

11. "Ein Analogrechner liegt vor, wenn man zur Lösung eines mathematischen Problems ein analoges physikalisches System aufbaut und die Lösung des Problems *durch ein physikalisches Experiment* gewinnt." E. Kettel, "Übersicht über die Technik der elektronischen Analogrechner," *Telefunken-Zeitung* 30, no. 116 (June 1957): 129. Italics mine.

12. Wolfgang Giloi and Rudolf Herschel, *Rechenanleitung für Analogrechner,* ed. Allgemeine Elektricitäts-Gesellschaft AEG-Telefunken, Fachbereich Anlagen Informationstechnik (Konstanz: n.p., n.d.), 13.

13. See, for instance, Heinrich Barkhausen, *Einführung in die Schwingungslehre nebst Anwendungen auf mechanische und elektrische Schwingungen,* 6th ed. (Leipzig: Hirzel, 1958), foreword.

14. *Operational Manual for the Heath Educational Analog Computer Model EC-1* (n.p., n.d.), 3.

15. "Dass Computersimulationen, verstanden als die verzeitlichte Imitation von Systemverhalten durch das Medium Computer, analytisch nicht zugüngliche Phänomene wie etwa Klima behandelbar gemacht haben, rückt sie in eine Position jenseits der tradierten Kategorien von Theorie und Experiment." Claus Pias, "Klimasimulation," in *2°: Das Wetter, der Mensch und sein Klima,* ed. Petra Lutz and Thomas Macho (Göttingen: Wallstein, 2009), 108–15, esp. 112.

16. "Der Erkenntnisvorteil von Simulationen liegt in ihren Extrapolationsmöglichkeiten für Bereiche, die zu klein oder zu groß sind, zu schnell oder langsam ablaufen." Gabriele Gramelsberger, "Im Zeichen der Wissenschaften," in *Schrift: Kulturtechnik zwischen Auge, Hand und Maschine,* ed. Gernot Grube, Werner Kogge, and Sybille Krämer (Munich: Fink, 2005), 448–49.

17. Eric Winsberg, "Simulated Experiments: Methodology for a Virtual World," *Philosophy of Science* 70 (2003): 120.

18. See Johannes Lenhard, "Mit dem Unerwarteten rechnen? Computersimulation und Nanowissenschaft," in *Nanotechnologien im Kontext: Philosophische, ethische und gesellschaftliche Perspektiven,* ed. Alfred Nordmann, Joachim Schummer, and Astrid Schwarz (Berlin: Akademische Verlagsgesellschaft, 2006), 151–68, esp. 159–60. In software engineering, a so-called event is meant to govern a momentary use of the computer program in nonlinear ways (often user orientation at interfaces). For example, the "interrupt" makes the mechanism wait for signal input from outside and in modeling an input leads to related "events." This is close to object-oriented programming; let us call it event orientation in the sense of an operative diagram.

Appendix

1. Wolfgang Ernst, *Das Rumoren der Archive: Ordnung aus Unordnung* (Berlin: Merve, 2002).