

## HANDS ON / OFF. (RE-)ENACTING TECHNOLOGY

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## HANDS ON / OFF. (RE-)ENACTING TECHNOLOGY

*abstract*

This paper deals with the ambivalences of the "hands on media" approach and the manual relation to technologies from a media-archaeological rather than anthropocentric perspective. The focus of analysis will be on technical media where the "digital" oscillates between the discretization of manual input (fingers) and the processing of numerical values.

The distancing of man from the physical world by the intervention of technical machines, apparatuses and automata, in cybernetic epistemology, is not necessarily a threat to humanism but has been experienced as a liberation of man from its overall subjectivity as well. Once human hands are on technical instruments for input or control, a servo-motoric coupling takes place - replacing the strong human agency by subjecting and submerging it to feedback circuits. The notion of hand-based instrument control literally extends to *time-axis-manipulation*.

The phenomenological notion of "hands on instruments" needs to be

rephrased in the language of engineering, of telegraphy, of typewriting and of digital computing. Traditional machinic typewriting does not ask for the hand as such any more; it radically differentiates the hands into ten discrete fingers. Finally the binary code reduces even decimal fingers to just two. What still looks like a playful *performative* handicraft, in reality is already a techno-mathematical *operation*. Even the painterly stroke dissolves into pixels. With "digitality" (no metaphor here), the human hand is radically mathematized.

The cybernetic coupling of human hands to the apparatus does not only refer to communication of man to machine in the present but the manual re-enactment of machines from the past results in a tempor(e)ality which is different from the familiar historical discourse. Once human senses are coupled with a technological (especially sonic) setting, man is within its autopoietic temporal field, a chrono-regime of its own dynamics (or mathematics, when data are registered digitally). Such couplings create ecstatic moments of time: Man is instantaneously taken out of the hand-made cultural world (which is Giambattista Vico's definition of "history") and confronts the naked technological *dispositif*. There is no "historical gap" inbetween as known from other aspects of cultural history - no historicism at the moment when hands are on past media.

## INTRODUCTION

### **Media archaeology and cybernetics: Beyond anthropocentrism in the "hands on" approach**

The author of the mathematical theory which is still the basis for digital communication engineering today, Claude Shannon, once built a toy consisting of a box with a switch. If you switch "on", a hand came out and automatically switched "off".<sup>1</sup> In that sense, this paper deals with the ambivalences of the "hands on media" approach and the manual relation to technologies. Hands progressively seem to get *off* instruments by automation. From the anthropological view, however, the hand-as-tool has always already had a transient status between the internal and the external: It has been both the central definition and already an extension of man.

The distancing of man from the physical world by the intervention of technical machines, apparatuses and automata, from the perspective of cybernetic epistemology (which equally considers

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1 On "Shannon's toys", see Axel Roch, Claude E. Shannon. *Spielzeug, Leben und die geheime Geschichte seiner Theorie der Information*, Berlin (gegenstalt Verlag) 2009

animal and machine as communicative systems<sup>2</sup>) is not necessarily a threat to humanism but has been experienced as a liberation of man from its overall subjectivity as well. In the introduction to his 1844 publication *The Pencil of Nature* Henry Fox Talbot explicitly remarks that the photographic illustrations "have been formed or depicted by optical and chemical means alone, and without the aid of any one acquainted with the art of drawing"; the objects are thereby not restricted to the idiosyncratic manipulations which accompany its representation when drawn by hand, "and considered only in its ultimate nature"<sup>3</sup>. Walter Benjamin in 1936 explicitly compared the surgeon rather with the cameraman than with the painter's hand<sup>4</sup> - as it had been expressed by Dziga Vertov's film *Man with a Camera* indeed. As long as the endoscope in medicine was a hand-driven camera inspection of the human body, it interlaces both practices of imaging: painting and optical media. Media archaeology adopts this "cold" gaze which is analytical rather than hermeneutical.

Once human hands are on technical instruments for input or control, a servomotoric coupling takes place - replacing the strong human agency by subjecting and submerging it to feedback circuits. That moment, man turns into a cyborg, a true cybernetic organism and becomes part of a closed circuit (German *Regelkreis*) in terms of systems theory, becoming nothing more or less than one (analog) element within a system circuitry. In any cybernetic man-machine configuration, hands do not subjectively direct and control any more, but become an integrated part of a system. The moment a human hand is on the radio tuning knob for getting reception resonance, man himself gets "tuned" to the tempor(e)alities of the technical medium. Thereby the human subject culminates in technology itself.

While transitive hand-machine relations might be subsumed under the field of studies called "cultural techniques"<sup>5</sup> and remains somewhat anthropocentric, media archaeology with its focus on nondiscursive human-machine constellations keeps a more ascetic distance to the human agency in favor of the technomathematical agencies themselves. For the purposes of such an analysis, the socio-cultural discourses that envelop technological processes

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2 The classic reference is still Norbert Wiener, *Cybernetics or control and communication in the animal and the machine*, Cambridge, Mass. (M.I.T. Press) 1948

3 Henry Fox Talbot, *The Pencil of Nature* [London 1844]; quoted here after the reprint New York (DaCapo Press) 1969, "Introduction" (no page)

4 See Walter Benjamin, *The Work of Art in the Age of Mechanical Reproduction* [1936], in: same author, *Illuminations*, London 1973, 238

5 See *Theory, Culture & Society*, vol. 30, no. 6 (November 2013), Special Issue *Cultural Techniques*, edited by Jussi Parikka / Geoffrey Winthrop-Young

must be momentarily suspended. Let us therefore rephrase the phenomenological notion of "hands on instruments" in the language of engineering. This even allows for a direct short-circuit between media-archaeological analysis and prehistoric archaeology. Not by coincidence it has been a palaeontologist who described the evolutionary externalisation of human memory into storage technologies.<sup>6</sup> The same is true for the haptic agency of the human hands.

## I TYPE-WRITING AND DIGITALITY

### **Telegraphic handicraft, "manipulation" and technology**

In the German dictionary *Brockhaus' Konversations-Lexikon* from 1894 the entry "Manipulation" is defined as artful handling, which extends as well to an almost techno-logical operation. A few years later, the rival dictionary *Meyers Großes Konversationslexikon* from 1908 adds the "Manipulator", defined as telegraphic input device (German *Taster*).<sup>7</sup> The Morse Code does not only include the electroacoustic dot and dash, but as well the temporal space inbetween, the pause (reminiscent of the so-called "silent piano", a special instrument for practicing keyboard playing without disturbing the surrounding area). All of the sudden, the haptic (as emphasized by McLuhan) extends to the microtemporal gap. But the hardware telegraph lines which were built to facilitate telecommunication suffered from heavy signal degeneration across space. When the signal became too weak, it had manually to be notated for new input; therefore a telegram sent between London and Kalkutta was frequently subject to improper transmission by personel with deficient language facilities. The solution was their replacement by nonhuman repeater-regenerators: the electro-magnetic (later vacuum-tube based) relay. Today, the binary codes allows to "write" by reducing the alphabet to only two symbols which can be operated by a simple movement of the hand: switching relays *on* and *off*.

### **Type-writing: The de-coupled relation of the hand to writing**

Traditional machinic typewriting does not ask for the undifferentiated hand any more; it radically separates the hands into ten discrete fingers. Finally the binary coding machine

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6 André Leroi-Gourhan, *La geste et la parole*, vol. I: Techniques et langage, Paris 1964; vol. II: La mémoire et les rythmes, Paris 1965, Paris (Albin Michel)

7 I owe this minute observation to Christopher Lorenz (his current re-reading of Theodor W. Adorno's mass media critique for a dissertation at Humboldt University, Berlin).

reduces even decimal fingers to just two.

Inbetween has been a very popular alternative to the ten finger-operated keyboard, the typewriter trade mark Mignon which at the beginning of 20th century was popular in Europe:

Fig.: Typewriter Mignon, from: Media Archaeological Fund, Humboldt University, Berlin. Photo: Ines Liszko

Here we find the alphanumeric input system reduced to a mouse-like pointer which is activated in the "binary" mode with just two keys for affirmation and for spacing.

The "digital" is not about hands, but fingers - even if Jeron Lanier in 1989 presented a data glove as an interface for navigating within virtual space; immersion here happens by an extended data *manipulation*. What still looks like a playful performative handicraft, in reality is already a techno-mathematical operation. While my fingers hack such thoughts in symbolical code on the keyboard of my laptop, the media-archaeological distance is aware that most writing is done within the microprocessors themselves where algorithms reign. Different from a typewriting machine which is still an instrument, the computer has already become what Gotthard Günther once called the "transclassical machine".<sup>8</sup>

According to Alan Turing's paper "On Computable Numbers" written at Cambridge in 1936, all operations of a calculating machine can be performed manually as long as man is equipped with squared paper, a pencil and a rubber gum. But at that moment, man is not authoring the process in terms of traditional literary writing, but himself is both servomechanically and mentally subjected to a sequence of discrete state, therefore becoming a "paper machine". The computer is transmanual - even though most users still experience and interface this machine by symbolic input *via alphanumeric* keyboards. Even the manual opening of the black box called personal computer does not lead to a more haptic and intuitive understanding of its algorithmic machinery. If one researches the inner side of a computer, one gets stuck with the circuitry and internal microchips. The computer becomes intangible.<sup>9</sup>

A manuscript once literally meant the handwritten unique document. With a law dating back to 1997 in Germany, the digital signature became legally equal to handwritten signature. Handwriting

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8 See Gotthard Günther, *Das Bewußtsein der Maschinen. Eine Metaphysik der Kybernetik*, Krefeld / Baden-Baden (Agis), 2nd ed. 1963, esp. supplement IV (Die "zweite" Maschine), 179-203

9 See Rainer C. Becker, *Black Box Computer. Zur Wissensgeschichte einer universellen kybernetischen Maschine*, Bielefeld (transcript) 2012, 12f

radically differs from machinic typewriting. Handwriting has been a common term for both the concrete individual writing (graphology) and more general for an individual style. This gap closes when etymologically referring back to the material instrument, Latin *stilus* which both inscribed and erased symbols on wax tablets. With the hand on the *stilus* to notate ideas in the alphabetic code, man already becomes a symbol-processing machine in the scriptural moment, but only the printing press inaugurated an epistemology of abstract combinatorics resulting in the mathematisation of writing.

Even the Gutenberg Bible emulates the look of handwriting by using types which express kalligraphic Gothic texture<sup>10</sup> and therefore dissimulates the technicality of identically reproducible letters - just as the letters on a computer screen dissolve into bit-mapped graphics when looked at "from behind".

In a deep epistemological sense, the writing and reading of discrete alphabetic letters preconditioned scientific analysis which literally is an elementary practice - different from "acoustic space" which (according to McLuhan) returned with electronic communication media. For the age of electricity, McLuhan identifies a return of the primordial (oral language-based) "tactility" in terms of the temporal moment with its decisive criterium being its (almost) instantaneous speed of transmission.<sup>11</sup>

### **Techné and keyboard**

Martin Heidegger differentiates ancient Greek *techné* as handycraft (German "Handwerk") from machine technique.<sup>12</sup> As opposed to the energetically hand-driven hammer as tool, a technology is a mode of control. In that sense, the hammer becomes a technological device only when it is included in a hammer piano - intermediated by fingers on the keyboard. The media philosopher Vilém Flusser interpreted the Baroque *toccata* as musical touch, the literal fingertip on the keyboard (with its German expression *Tastatur*).<sup>13</sup>

10 See Sonja Neef, *Abdruck und Spur. Handschrift im Zeitalter ihrer technischen Reproduzierbarkeit*, Berlin (Kulturverlag Kadmos) 2008, 91

11 See Till A. Heilmann, *Digitalität als Taktilität. McLuhan, der Computer und die Taste*, in: *Zeitschrift für Medienwissenschaft* 3, no. 2 (2010), 125-134 (128)

12 See Martin Heidegger, *Leitgedanken zur Entstehung der Metaphysik, der neuzeitlichen Wissenschaft und der modernen Technik*, Frankfurt/M. (Vittorio Klostermann) 2009, 301

13 See Rainer Guldin, "To make music with visionary power": On the Relationship of Music and Mathematics In Vilém Flusser's Work, in: *Flusser Studies* 17 - Music and Sound in Vilém Flusser's

One special key-stroke instrument in the collection of the Musikinstrumentenmuseum Berlin is the *Liebmanista*, manufactured for a piano player who had lost most of his fingers in World War One. By pressing single keys it allowed for playing whole accords; this is a reduction of the hand to code. The transformation of the "digital" keyboard operated by decimal fingers to the binary sense of computing took place with the *Synclavier II*, an electronic piano as digital synthesizer.<sup>14</sup> All of the sudden, the keyboard as coupling between fingers and mechanism, even if it is still perceived as "instrumental", becomes a sublime cybernetic coupling between human and machine.

### ***Digitality instead of the whole "hand": fingers and numbers***

Hands on instruments in the engineering sense means *soldering* as analog technique; this is opposed to typewriting and programming in the digital code. Doing things symbolically (machine notation) differs from wiring and patching electronics manually close to the "real" of hardware.

The traditional counting device *abacus* always operated on discretisation. Numerical computing differentiates the hand into fingers, performing "analysis" (elementarization) with which - different from geometrical drawing - symbolic notation (alphabetical and numerical mathematics) corresponds. In chapter 11 of *Understanding Media* McLuhan defines the nature of the number as "an extension and separation of our most intimate and interrelating acticity, our sense of touch"<sup>15</sup>. A media-archaeology of the digital detects the correlation between discrete arithmetic calculation and touch indeed. Tactility in digital mathematical machines is different from the discrete fingertip operations of the symbolic machine called typewriter. Counting in times of mechanized mathematics takes another dimension which is algorithmics.

There is a tight coupling between the digital and number *manipulation*. The classic gesture of telephoning culminated in dialling with 10 numbers being addressed manually by the index finger (Latin *digitus*). But the meaning of the digital in current media culture rather refers to computer-based technologies. More precisely, the real message of the digital is the binary code - which in fact reduces the hands with 10 fingers to just two micromovements of on/off gestures.

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work; online <http://www.flusserstudies.net/current-issue> (May 2014)

14 Operated by a *n.e.d.* computer ("new england digital" company) with a VT 100 graphics monitor.

15 McLuhan 1964: 107

The "human" hand has always been a mechanism as an interface in the technical sense. The uncanny of the hand is its function in the autonomous brain-hand-system in the cybernetic sense. Faced with robotic and other prosthetic "hands", humans are not sure any more if this is an integral human body part, its extension or alienation. The discretization of the human hand into single fingers as a function of cultural evolution culminates in character writing. This technically corresponds to digital sampling as the central momentum in the conversion of analog signals from the physical world into numerical computing. Its German equivalent is a very manual term indeed: "abtasten".

### **Between manual and digital painting**

According to McLuhan, "the stipple of points of Seurat is close to the present technique of sending pictures by telegraph, and close to the form of the TV image or mosaic made by the scanning finger" of the cathode ray tube. "All of these anticipate later electric forms because, like the digital computer with its multiple yes-no dots and dashes, they caress the contour of every kind of being by the multiple touches of these points. Electricity offers a means of getting in touch with every facet of being at once, like the brain itself. Electricity is [...] primarily tactile"<sup>16</sup>. Even if McLuhan obviously confuses digital pixels with random distribution of chemical picture elements in photography and the painterly stroke in *pointillisme*, he is right in terms of the electric impulse.

Already "[...] photography made people realize that art was not necessarily the manipulation of a plastic substance like paint or materials of any kind. It is an act of selection, you press the shutter."<sup>17</sup> Only with computer-based imagery, in a kind of unexpected recursion, the artistic hand comes back to manual picturing, but not in a painterly mode any more: "The artist no longer directly touches or manipulates color, material, or objects. He or she manipulated algorithms, which are more or less abstract"<sup>18</sup> - which indeed requires an education beyond the traditional Art Academy. The binary code of digital signal processing results in a radical mathematization even of the

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16 McLuhan 1964: 247 f.

17 Jonathan Benthall, *The Computer as Medium*, in: Margit Rosen (ed.), *A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Arts. New Tendencies and Bit International, 1961-1973*, Karlsruhe (ZKM) / Cambridge, Mass. (MIT) 2011, 461-465 (461)

18 Abraham A. Moles, *Introduction to the Colloquy* [sc. *Computers and Visual Research*, Center for Culture and Information, August 3-4, 1968, Zagreb], reproduced in: Rosen (ed.) 2011: 263-266 (265)



painterly hand. But maybe traditional painting here proudly resists, all the more, gaining pride and strength from the *retro-effect* of manual easel painting *versus* the type-writing act of algorithmic imaging and programmed computer graphics.

## II HANDS ON THE ARTIFACTUAL PAST

### **Re-enacting the past**

Different from the discursive tendency to think history and time in terms of narrative, let us focus on truly media-generated temporalities in machine-specific terms. Such a media archaeology leads to a kind of epistemological reverse engineering. In a way unlike frozen museum displays, one can experience the media-cultural past by literally getting "in touch" with the artefacts. At Humbolt University's Media Archaeological Fund, a configuration of apparently "dead historical" media devices can be operationalized through playful tinkering.<sup>19</sup> In this sense the question of media dynamics and agency is taken seriously.

Fig.: Insight to the Media Archaeological Fund

The interpretation of media is nothing without doing; a technical artifact discloses its essence only when operating. According to Martin Heidegger, everyday things are either *zuhanden* (ready-to-hand) or *vorhanden* (present-to-hand).<sup>20</sup> Once human senses are coupled with a technological setting, man is within its autopoietic temporal field. Such couplings create ecstatic moments of time: Man is instantaneously taken out of the immediate cultural world (which is Giambattista Vico's definition of "history") and confronts the naked technological *dispositif*.

### **Manual experimentation of time with machines**

"Operativity" is essential for the definition of technical media. If the cultural and discursive knowledge of technology is not limited to illustrations in texts and books, to distant observation in museums and to pure documentation in archives, there is a need for platforms where technical objects can be operated "hands on" in their primary materiality.

Let us draw here an analogy between musical instruments and electronical media since both are "time-based" in their essential

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<sup>19</sup> See <http://www.medientheorien.hu-berlin.de/fundus>; operational videos can be activated under the URL <http://www.youtube.com/user/HUMediaStudies>

<sup>20</sup> See Martin Heidegger, *Sein und Zeit* [1927], Tübingen 1993, 69

function. They come into being only as "time objects" (*Zeitobjekte*, according to Edmund Husserl's phenomenology). A primary scene of "hands on media" has been the experimental use of the one-string instrument as measuring device - the ancient *monochord* with which the Pythagorean calculation of harmonic sound ratios once started. The monochord in fact allows for a sonic time-tunneling by shortcutting the apparent cultural-historical distance which separates the present from antiquity. If we consider the monochord as an operative medium, it becomes a way to demonstrate an alternative approach to get in touch with knowledge from the past. The mathematical principles of even such simple techniques enable a circuiting between the present and antiquity, establishing a performative link. Whenever we lay hands on the monochord, we share at least a bit of that past knowledge that is actually not past when it sounds - a sort of "re-presencing".<sup>21</sup>

The best method to understand a medium is by its re-engineering and its functional re-enactment. Charles Sanders Peirce describes diagrammatic reasoning as such: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."<sup>22</sup> - just as we share Pythagoras' sono-mathematical experience by operating the monochord with our hands today. Collingwood equally reminds of the endurance of Pythagoras' geometric discovery concerning the square on the hypotenuse. It is just that the present mind must be somewhat *tuned* in the right cognitive mood.<sup>23</sup> We are certainly not in the same historical, that is: contextual situation like Pythagoras, since the ways of listening and the psycho-physical tuning are different. But with our haptic organs (ears and fingers) "on" the monochord, we experience a time-machine in a different sense: It lets us co-originarily participate at the discovery of musicological knowledge. As has been argued in Jacques Derrida's *Grammatology*, the repeatable *is* the original.<sup>24</sup>

In the Italian *renaissance* of knowledge from antiquity, Vincenzo Galilei performed a number of experiments to investigate the nature of musical harmonics<sup>25</sup> as a kind of media-based archaeology

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21 See Vivian Sobchak, *Afterword: Media Archaeology and Re-presencing the Past*, in: *Media Archaeology: Approaches, Applications, and Implications* (Berkeley: University of California Press, 2011), 323-33

22 Charles Sanders Peirce, *Collected Papers*, vol. II: *Elements of Logic*, Cambridge, Mass. (Harvard UP) 1932, 350

23 R. G. Collingwood, *The Idea of History* [\*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 217f.

24 Martin Heidegger, *Sein und Zeit* [1927], 16th edition, Tübingen (Niemeyer) 1986, 385: "Die Wiederholung ist die ausdrückliche Überlieferung, das heißt der Rückgang in die Möglichkeiten des dagewesenen Daseins."

25 As described in: Vincenzo Galilei, *A Special Discourse Concerning the Unison*, trans. in Claude V. Palisca, *The*

of the acoustic, employing the lute not as a musical instrument but as a piece of laboratory equipment. Once human hands are involved with experimentation time, the past can be re-enacted. On the diagrammatical level, the re-enactment is time-invariant; on the operative level of implementation, the materiality of the medium itself - even if it imposes certain vetoes due to the historicity of the instrument - the epistemological operation remains intact *in principle* (archaeologically). When a researcher set out to replicate Galilei's experiment using a lute built in the 17th century, the present condition of the instrument required the use of some substitutions for the materials originally used by Galilei in his experiment; "however, these did not affect the basis tenets of the experiment"<sup>26</sup>. In the processual event of the reenacted experiment one shares the same temporal field. Hermann von Helmholtz was sceptical about the possibilities to truly re-enact a musical experience in the past; we are dependent on historical information indeed.<sup>27</sup> But media-archaeological experimentation (simulation as opposed to historicism) allows for access to the invariant elements of knowledge in time indeed.<sup>28</sup>

But for computational media, the sound of the archive is not activated by manual re-play any more but by emulation without human intervention. The software simulator of the archaic British EDSAC electronic computer (designed for museological re-enactment) allows for an explicit "analogy between a computer program and a musical score - once described as 'frozen music' needing only an orchestra to melt it"<sup>29</sup>.

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Florentine Camerata. Documentary Studies and Translations, New Haven / London (Yale University Press) 1988, 203-205

26 Claude V. Palisca, Was Galileo's Father an Experimental Scientist?, in: Paolo Gozza (ed.), Number to Sound. The musical way to the scientific revolution, Dordrecht / Boston / London (Kluwer) 2000, 191-199 (195)

27 Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Braunschweig (Vieweg) 1863; reprint of the 6th edition (Braunschweig 1913): Hildesheim / Zürich / New York (Olms) 1983, 411

28 See Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: MusikTheorie. Zeitschrift für Musikwissenschaft, vol. 22, no. 4 / 2007, 295-316 (313f)

29 Martin Campbell-Kelly, Past into Present: The EDSAC Simulator, in: Raúl Rojas / Ulf Hashagen (eds.), The First Computers. History and Architecture, Cambridge, Mass./ London (MIT Press) 2000, 397-416 (399). The operations of this Electronic Delay Storage Automatic Calculator were themselves based on a set of *acoustic* mercury delay lines - a serial access memory which enacted a cyclic, ultrasonic rhythm.

## Symbolical re-enactment of machines: From YUGO back to Babbage

Different from signal storage media like photography and phonography, the type-written transmission of information from the past in the alphabetic code puts the receiver into a machine-like decoding mode which cuts short the "historic" temporal difference in favor of immediate communication. Therefore "[...] the historian may re-enact a past event if that event is itself a thought"<sup>30</sup>. The symbolically coded channel of tradition is to a high degree time-invariant, thereby ahistoric.

"[...] one and the same act of thought may endure through a lapse of time and revive after a time when it has been in abeyance. Take a [...] case [...] where the interval covers the whole lapse of time from Euclid to myself. [...] Euclid and I are not (as it were) two different typewriters which, just because they are not the same typewriter, can never perform the same act but only acts of the same kind. A mind is not a machine with various functions, but a complex of activities [...]. Granted that the same effect can happen twice in different contexts within the complex of my own activities, why should it not happen twice in two different complexes?"<sup>31</sup>

Symbolic operations can indeed be re-enacted against historical time which has passed inbetween. A "manual" (German *Handbuch*) for motor cars serves for enacting a machine even if it seems past.

Fig: YUGO / Zastava. Owners Workshop Manual

The manual<sup>32</sup> for the British edition of the ex-Yugoslavian YUGO car is not only readable as an instructive metatext but in going down to the minutest detail it is itself almost a paper machine. It allows to deconstruct and to reconstruct a Yugo from scratch. The visual algorithm of the manual is convincing: "The tasks are described and photographed in a step-by-step sequence so that even a novice can do the work"<sup>33</sup> - which is chronophotography in the best pre-cinematographic tradition of Marey and Muybridge. The cover has a jacket proudly comments: "Every Manual based on a complete Stripdown and rebuild".

Charles Babbage once invented his "mechanical notation" in order to avoid the time- and cost-consuming task of actually building a designed calculating machine by handicraft. The hand becomes a symbol-drawer instead of hand-writing. This reminds of Turing's argument developed in 1936: calculations performed by humans with

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30 Collingwood's 1928 lecture "Outlines of a Philosophy of History", in: same author 1993: 443

31 Collingwood 1928/1993: 287f

32 YUGO / Zastava. Owners Workshop Manual, Somerset (Haynes Publishing Group), 2nd ed. 1990

33 YUGO / Zastava Manual, p. 5

symbols written and erased on paper turns man himself into a "paper machine".<sup>34</sup>

While Franz von Reuleaux' symbolical notation accentuates the machinic modules, Babbage accentuates the temporal flow.<sup>35</sup> The mechanical notation would thereby allow to reproduce the procedural behaviour of the designed machine, as expressed in his so-called Timing Diagram (cyclling units) and Flow Diagram which is well known today from flow charts in computer programming. By introducing time into the symbolic regime, the machine starts to operate. It was Babbage's mathematical companion Ada Lovelace who decoupled mechanic computing of mathematics from the subject-centered human hand: "The science of operations [...] is a science of itself, and has its own abstract truth and value, just as logic has its own peculiar truth and value, independently of the subjects to which we may apply its reasings and processes."<sup>36</sup>

Later in the 1930s, when logical reasoning was applied to switching systems to develop electromechanical calculators, Claude Shannon demonstrated that Boolean logic could be applied to the same types of problems for which Babbage had designed his mechanical notation.<sup>37</sup> Here we perceive technological time in a double-bind between media history and media archaeology: On the one hand, Babbage's Analytical Machine was not realized in 19th century due to mechanical, financial and epistemological restrictions; on the other hand, by means of his mechanical notation the machine can be re-enacted today without loss. For Babbage's bicentennary, the Science Museum has (re-)built the Difference Engine indeed. There is no historical gap inbetween as known from other regions of cultural history - no historicism in "hands on past media".

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34 See Alan Turing, *On Computable Numbers, with an Application to the Entscheidungsproblem*, in: *Proceedings of the London Mathematical Society* (2), Bd. 42 (1936), 230-265

35 See Berz 2001: 181

36 James Essinger, *A female genius: How Ada Lovelace, Lord Byron's daughter, started the computer age*, London (Gibson Square) 2014, 173

37 Jeremy Norman, *Describing the Logic and Operation of Machinery by means of Notation*, *online*  
<http://www.historyofinformation.com/expanded.php?id=3179>