

Before Ink Starts to Blink Scripts and Diagrams on Paper as Interfaces for Machines and Humans (in Creative Processes)

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Abstract

Creative processes, which can be treated as live performative acts, are seen nowadays as an interplay of humans, materials, media and machines. Interfaces are a part of this and often understood as technical devices, which bridge between humans and machines – Ivan Sutherland's *Sketchpad* counts as a prime example for it. Picking up this historical case this media-theoretical paper wants to introduce scripts and diagrams on paper as interfaces for machines and humans. Coming from historical case studies it will be shown that both media with regard to their operativity have to be considered even as “auto-interfaces”, which allow for example to influence someone's self. Therefore scripts and diagrams as well as the interface-concept will be reflected media-theoretically. Thus, the paper expands the interface-discourse and links it to media theory, especially to diagrammatics and notational iconicity and provides a better understanding of creative processes based on handwriting or -drawing.

Keywords

Interface
Interactivity
Script
Diagram
Media
Machine
Computer
Creative Process
Art & Science

Introduction

On January 7th, 1963 the electrical engineer Ivan Sutherland submitted his doctoral thesis at Massachusetts Institute of Technology about a computer system, which he developed in the field of computer-aided design-research. He wrote: “The Sketchpad system makes it possible for a man and a computer to converse rapidly through the medium of line drawings.” (Sutherland 1963, 8) His graphical user interface (Figure 1), is nowadays seen as groundbreaking (Pias 2002, 60ff), because it marks the change of the computer from a machine of experts to one of everyman (Pratschke 2008, 68). Since this time an interface is understood foremost as a so-called human-machine-interface (HMI). Thus, the term “user interface” describes today these components, which provide a place like a surface,¹ where humans can act, to interact with a machine and control it (Pias 2003). The interface serves as a “bridge”² (Hellige 2008a, 7). Instead of only pressing buttons on a keyboard,³ in *Sketchpad* one can point at something and operate (in combinations with buttons) on a screen. For our purpose, it is important to notice that the term “interface” does not mean necessarily a human-machine-configuration. *Merriam Webster’s Collegiate Dictionary* characterized an “interface” in 2003 as “the place at which independent and often unrelated systems meet and act on or communicate with each other” and further “a surface forming a common boundary of two bodies, spaces or phases”.⁴ The description “two phases” refers to the origin in the fields of chemistry at the end of the 19th century and electrical engineering, where it denotes the boundary layer or surface of two liquids or the transition between technical components of a system. At latest in the 1950s it was widened out onto the interaction between man and machine (Hellige 2008b, 13). Hence hardware-interfaces, hardware-software-interfaces, software-interfaces, network-interfaces and last but not least human-machine-interfaces

have been distinguished.⁵ But the article in *Merriam Webster’s Collegiate Dictionary* makes aware of two important aspects: First, it is not spoken of machines at all, but in a general, unspecified meaning of “unrelated systems” and explicitly of “bodies”. Actually, the term “interface” is related also to “human-human-interfaces” which is even illustrated with a pictogram in the dictionary for computer science *Duden Informatik* in 2001.⁶ And it is explicitly not meant a human-human-configuration based on a machine, especially when the distribution-property of the internet is used for chat, e-mail, etc. (Goertz 2004, 99). On the contrary, in literature the human-human-interface (HHI) is described as independent and antecedent to the technical sphere (Balasis 2003, 246f).⁷ It is even indicated that HMI-design profits by the analysis of human-human-interfaces.⁸ The second aspect is that communication is distinguished by interaction. This is important, because interfaces can serve for both. A precise differentiation of the terms, which have become in our daily use fuzzy and often synonymical, is not easy, because their relationship is described in disciplines like communication theory, sociology or computer science in different manners, sometimes as subsets of each other, sometimes as independent from each other and sometimes as only appearing together (Neuberger 2007, 36ff). For a better understanding, a short reconstruction shall be provided.⁹ Originated in sociology, “interaction” means (according to the German term “Wechselwirkung”) an active, consciously two-way or reciprocal influencing of persons on each other to coordinate actions or behaviour (Neuberger 2007, 36; Goertz 2004, 98). Because successful interaction requires an adequate interpretation by all participants concerning the actions, motivations and purposes of the counterparts, some authors argue that social interaction has to be considered always as communication, which can be understood as an exchange of information via language for an understanding among humans (Neuberger 2007, 36f.; Jäckel 1995). This sociological

¹ Also three-dimensional spaces (equipped with sensors) can function as interfaces.

² All translations from German to English language are done by the author.

³ *Whirlwind*-MIT-team was talking in the 1950s about “keyboard interactions” (Hellige 2008b, 32).

⁴ *Merriam Webster’s Collegiate Dictionary*, 11th ed., s.v. “Interface.”

⁵ Duden Informatik, Ein Fachlexikon für Studium und Praxis,

3d ed., s.v. “Schnittstelle.”

⁶ Ibid.

⁷ French phenomenology argues, that there is always an interaction between our bodies and the surrounding world (Halbach 1994, 140ff.).

⁸ Ibid.

⁹ See also *Grundbegriffe der Medientheorie*, ed. Alexander Roesler and Bernd Stiegler (Paderborn: Wilhelm Fink Verlag, 2005), s.v., “Interaktivität.” and GamesCoop 2012, 80ff.

notion of interaction was transferred onto the processes between human beings and computers, to indicate the leap in quality from a serial batch-program to a dialogue mode (Pias 2002, 60).¹⁰ Although it is accepted that “communication in a language is the most important form of human interaction”,¹¹ interaction can also happen without it (Luhmann 1993, 81). For example, when two tightly entwined organisms react to the movements of each other, neither using a spoken language nor with exchanging or interpreting information consciously. Or how Ivan Sutherland puts it: “Boxers interact, but don’t communicate. Poets communicate but don’t interact.”¹² In other cases communication does not allow interaction, because it happens in a one-way or so called unidirectional mode, so there is no possibility of influencing each other (Jäckel 1995, 36).¹³



Figure 1. Ivan Sutherland's Sketchpad (1961-63).

Source: Evan Yares. 2013. 50 Years of CAD. Design World. 13.02.2013. <https://www.designworldonline.com/50-years-of-cad/> (22.02.2018).

Seizing on Sutherland's *Sketchpad*, which was linked to conventional drawing, I want to apply the concept of an interface to analogue graphical media script and diagram and make it productive for them, assuming, that not only “technical images” (Pratschke 2008) can serve

as graphical interfaces. The central question is: How can scripts and diagrams do so? To answer this, they will be characterized with more details. Because they are understood like the computer as a “medium of communication and information” (Hellige 2008a, 7), it must be shown, that they serve also for interaction. This will happen in three parts: In the first one, I want to show with historical case studies that scripts and diagrams on paper have a certain tradition to serve as interfaces in human-machine-configurations. Secondly, I want to demonstrate, that both function as human-human-interfaces with the example of a didactic situation. Finally, it will be explained, why scripts and diagrams could be understood as “auto-interfaces,” how I want to describe them. Therefore, interfaces here are not only diagnosed concerning their ontological properties, but also the practices and functionalities they offer. This happens on the basis of such interface-theories, which consider an interface more as a process combined with practices and not only as a product like a technical system (Drucker 2011; Galloway 2012).¹⁴ By introducing scripts and diagrams as interfaces this paper wants to illuminate and expand the interface-concept. To do this the interface-discourse will be linked up to diagrammatics and media theory and an interdisciplinary bridge build. Picking up thoughts of mediaphilosopher Sybille Krämer, especially the idea of operative media, this approach – media as interfaces – wants to fill at the same time a diagnosed gap in her media theory (GamesCoop 2012, 41), although she was describing script as an “operating room” (Krämer 2005, 23) and was bringing “interaction with symbols” and “computer user's interfaces” close together (Krämer 2008b, 38). This approach can be also interesting for artists, because interfaces and interactive art are two sides of a coin. Finally, a better understanding of paper-based (artistic) creative processes will be enabled.

¹⁰ Although machines are not (yet) consciously acting (Fuchs 1991, 45). Mertens suggested to speak instead of “navigation” and possibilities of “intervention” and “control” (Mertens 2004, 273).

¹¹ Duden Rechtschreibung Online, „Interaktion,“ <https://www.duden.de/rechtschreibung/Interaktion> (accessed October 14, 2014).

¹² Ivan Sutherland, e-mail conversation with the author,

November 21, 2014.

¹³ For some authors a one-way communication is not a communication and only a multi-channel face-to-face-communication (with mimics and gestures) is accepted as interactive.

¹⁴ Similar to the concept “media” in media theory it was argued in a poststructural manner, that interfaces are made in a certain historical and cultural situation.

1. Scripts and Diagrams as Human-Machine-Interfaces

When Jack I. Raffel, employee at MIT informed Ivan Sutherland at the end of the summer of 1960 about the research interest of Lincoln Laboratories, to make the computer “more approachable” (Sutherland 1963, 24) using its display, it was a declared goal to improve the interaction between the user and the machine. This was a widespread thought and wish at this time (Brooks 1965; Hellige 2008b, 12ff.). To realize it, two strategies exist: Either the computer becomes more human-like or people must get engaged in the specifications of the machine. This is because computers work with invisible data and humans work sensually with visible, tactile and audible media, as mediaphilosopher Claus Pias explicated (Pias 2003). *Sketchpad* allowed a more user-friendly interaction with a kind of electronical drawing by pointing on the screen, assisted by a “light pen” and buttons, as Sutherland described it in his dissertation, and he points out: “The sketchpad system uses drawing as a novel communication medium for a computer.” (Sutherland 1963, 2) The crucial advantage was: “Except for legends, no written language is used”. Instead of programming the user handles geometric objects on the screen (with a light pen). Drawing on paper has become a showing on the screen, because the machine is working with signs of a prepared written program – an “auto-operative script” (Grube 2005, 97) – in the background, how computer scientist and computer art pioneer Frieder Nake argued (Nake 2008, 146ff.). In a MIT-documentation-video about *Sketchpad* from 1964, in which co-worker Timothy Johnson demonstrates the operating, Steven Coons, co-director of Lincoln Labs, explained: “In the old days to solve a problem, it was necessary to [...] write out in detail on a typewriter or in punchcard-form all the steps, all the regulations [...]” (MIT-Video 1964, Min. 2:36). With regard to punch cards Sutherland wrote in his dissertation: “[...] in the past, we have been writing letters to rather than conferring with our computers.” (Sutherland 1963, 8) In the middle of the 19th century mathematician

and philosopher Charles Babbage used such coded ‘letters’, punch cards (or punched paper tapes), which were invented for Jacquard-loom, for its calculating machine *Analytical Engine*. The “orders to the machine” happened by “arrangements” of different “sets of cards”, each representing data, working steps and operations (Babbage 1989, S. 45f.; Hellige 2008b, 23). They gained a bigger prominence in the context of the American census in 1890, when engineer Herman Hollerith developed it further, to use it as a data storage for calculating machines (Figure 2). The punch card can be understood as a script¹⁵ on paper for a machine, which can be decoded only by an especially trained and experienced human. But different to other common and haptic scripts for humans like Braille, which was developed in 1825 and discussed as an example for the importance of spatiality in writing (Grube and Kogge 2005, 14.), the form and relative location of a single marking to another is not relevant, but the absolute location on the paper. Like in a Cartesian coordinate system the meaning is determined by the concrete position of an element in the field of a system. It is a symptom of a diagrammatic representation, when places, fields or areas are predefined semantically (Bogen and Thürlemann 2003, 7f).¹⁶ So punch cards must be understood more as diagrammatic than written representations – diagrams for a machine.

The developers of *Sketchpad* wanted to replace such traditional paper-interfaces at least because of two reasons: They were machine-coded media, thus difficult to comprehend and communicate. And for problem-solving “all the steps” of a solution needed to be described in advance. Concerning this matter *Sketchpad* could be applied easier and more understandable (Nake 2008, 143f.) Solutions could especially be found interactively by trial and error in a creative process – (programming could also be experimented with, but in the 1960s the process was much more lengthily). But even more efficient and ergonomic would have been a human-machine-interaction, which is similar to the most basic human communication: natural,

¹⁵ Here meant in the sense of a notation and not a computer-script as a small program.

¹⁶ Space is also regarded as an essential ingredient of scripts, which are ‘living’ on the two-dimensional surface of the support, but it is the sheet of paper that – culturally determined – defines the surface in a topological manner (top, bottom, center, left, right) and its meaning (Schapiro 2006).

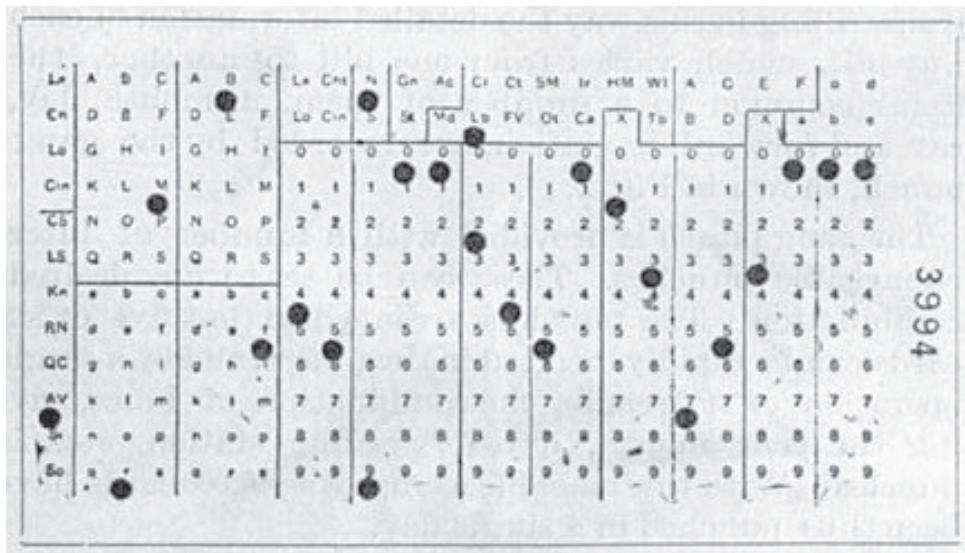


Figure 2. Hollerith-punch card in Railroad Gazette (1895). Source: https://en.wikipedia.org/wiki/Punched_card#/media/File:Hollerith_punched_card.jpg [03.10.2014]

spoken language. In this way *Sketchpad* was announced metaphorically in the MIT-demonstration-film as a “graphical language”,¹⁷ which could be used for “talking graphically”.



Figure 3. Still of the TV-show *I've got a secret*, CBS Television (18. November 1959) (Min. 6:50). Source: <https://www.youtube.com/watch?v=v2HM1DvQUdk> (03.10.2014).

The idea to communicate with computers via spoken or written words was in circulation at the latest since the 1930s. After initial positive results by analyzing spoken language, it became clear in the 1960s that voice recognition was not as easy to realize; stimulated by

pattern recognition, which was already used with punch cards, the idea of character recognition of text as a more human-like procedure was pursued (Hellige 2008b, 30ff). A computer like this, named *Analyzing Reader*, which could recognize text done by typewriter and print it as a punched paper tape, was invented in the 1950s by David Shepard and presented in the popular TV-show *I've got a secret* (1959) (Figure 3).

Even if the text does not serve explicitly to control the machine, it does it implicitly, because otherwise the text would not have become translated. In any case the information to control the machine could be saved in a natural language on a simple storage medium, again a sheet of paper. It can be read easily by humans, without technical equipment. Like the punch card, this example shows, that paper-based storage media were invented and applied as interfaces – (still today the machine-readable lottery ticket exists as a popular one). Optical character recognition (OCR) of handwritten text, which mathematician and computer scientist Alan Turing thought to be realized already in the 1950s, worked not faultlessly before the 1970s (Hellige 2008b, 30f.).

¹⁷ Steven Coons: “Now, he is going to be talking graphically, he is going to be drawing and the computer is going to understand these drawings. And the man will be using a language, a graphical language, that we call *Sketchpad*, that started with Ivan Sutherland some years ago, when he was busy with his doctoral degree.” (MIT-Video 1964, Min. 0:58)

In a historical review *Sketchpad* appeared at the right time, to satisfy the need for an easy human-computer-interaction. The system offered a third way: not speaking, not writing, but drawing as a familiar means of communication. We remember, Sutherland was talking about “[through] the medium of line drawings”, although he points out, that it is different to traditional drawing, namely “an active process which leaves a trail of carbon on the paper” (Sutherland 1963, 102). *Sketchpad*, that at the same time realizes and overcomes drawing on paper, shows the great importance of traditional graphical practices like drawing and writing. *Sketchpad* imitates the sketch and the geometrical and engineering drawing to a certain kind. A media-archaeology uncovers that Timothy Johnson refers in the MIT-demonstration-film to the tradition of graphical practices: He compares *Sketchpad* with a “pencil-paper-drawing” and explains the delete-function with “you have several pieces of paper” (MIT-Video 1964, Min. 6:08; Min. 8:45). He does it, to make clear that the electronic drawing would – different to paper drawing – understand what has been drawn. Last but not least, Johnson points with a gesture to the characters “INK” (MIT-Video 1964, Min. 4:29), which as an electronic script are blinking on the screen, being like a reminiscence to traditional writing and drawing done by hand (Figure 4). One can only speculate, if Ivan Sutherland was influenced by the popular animation series *Out of the Inkwell*. Its animator Max Fleischer reactivated it around 1960 and had invented the Rotoscope before as a device for creating it: a glass plane served both for projecting film on and as a drawing surface (Pointer 2017, 23ff.). In any case, *Sketchpad* itself gives reason to examine the potentiality of traditional graphical practices as interfaces, especially in times *before ink starts to blink*.



Figure 4. Still of the *Sketchpad* MIT-Demo (1964) (Min. 4:30). Source: https://www.youtube.com/watch?v=USyoT_Ha_bA (03.10.2014)

2. Scripts and Diagrams as Human-Human-Interfaces (HHI)

It is well known, that media play an essential role in interpersonal communication. It is, so to say, their constitutive property to mediate. In particular with scripts and diagrams on paper ephemeral knowledge can be permanently fixed on a support, thus transported in space and time.¹⁸ Hence such graphical media are understood, according to Niklas Luhmann’s media theory, as “media of distribution” (Luhmann 2001, 81f.). Luhman, for whom communication is *the* basis for social systems, categorizes media depending on their potential to transform improbable communication, which is with regard to “understanding”, “reachability” and “success” a premise for him, into a (more) probable one (Luhmann 2001, 78ff.); and media of distribution could do so when exceeding the “communication between attenders” in a spatial or temporal manner when attention and response could no more be guaranteed – (it seems that Luhmann in 1981 still had the idea that a face-to-face-communication could only be imitated insufficiently with technical media).

Using the example of a learning situation in a school or university, where the participants discuss a common problem or topic at a board, shall now be argued, that scripts and diagrams

¹⁸ Bruno Latour speaks of an “immutable mobile.” In oral cultures knowledge can be passed (from one to another generation) with a chain-communication.

play in this process an important role and how they serve as interfaces between humans or function as human-human-interfaces – (it does not matter, if the writing happens with chalk on a board or with ink on a flipchart). In such a face-to-face communication plays the spoken word an essential role along with facial expressions and gestures. Media science is talking about “primary media” (Pross 1972, 127ff.), which are linked to the body and do not need any use of technology. It is important here, that Luhman describes the get-together of attenders, who are close, as a “system of interaction” (Luhmann 2001, 78) and actually face-to-face communication is also mentioned as a model for “interactive media” (Goertz 2004, 100), because “sender and receiver use all their senses, the reply is immediate, the communication is generally closed circuit, and the content is primarily informal or ‘ad lib’” (Durlak 1987, 744). As an aside, the “list” has been suggested by Jack Goody as an “interface between the written and the oral” (Deicher 2014, 14). What about our learning situation? People met to learn, which means in general to acquire mental and/or physical knowledge, skills and abilities with and from each other. Here speech, gestures, script and diagrams are playing together. Scripts and diagrams allow not only to visualize abstract thoughts, they make them visible and bring them home to the participants. Under discussion these representations of certain issues on the board can also be pointed and referred to (Meynen 2007), so they can be retraced intersubjectively. Thus, a kind of symbol based or symbolic interaction happens (Goertz 2004). Especially physics and mathematics make aware about the practise of showing in a double meaning, when the participants argue and prove with reference to the board. Didactics knows that (visual) media can function as a corrective to language in group-communications (Lorenz 2005, 163). Like every medium the script as an immaterial concept is only thinkable with a material support, and the materiality offers specific properties for the interaction. The writing can be edited while having a conversation, that means something could be added

or erased by wiping away. The same goes for diagrams. Especially the duplication or parallel use of media allows a better interactive, instant comparison of a content, when spoken and written language correspond and must be translated in one another. It is well known in didactics that such processes increase the success of communication. (Lorenz 2005, 156ff.) Our case example shows, that Luhman’s categorization of single media makes sense to explain the probability of a successful communication in general, but does not in special, mixed-media settings; Graphical media need not necessarily serve as media of distribution. On the contrary, writing and drawing can be a social practice, a kind of acting as part of a group-communication-process. In fact linguist Karl Bühler used writing on a board as an example within his organon-model, in which he distinguished the “representation”, the “appeal” and the “expression” as three functions of language, to describe that the way someone writes on a board, can be diagnosed as an expression of his personality (Bühler 1999, 32). Since graphical media here are bound with social interaction in a system of interaction, they rather must be regarded as media of interaction. That is why scripts and diagrams are interfaces, which offer both a surface and a place, where actors can communicate with and influence each other.

If we take into account that Ivan Sutherland used scripts and diagrams in his research and teaching – he liked especially flow diagrams¹⁹ – and was aware of the advantages of media for creative processes (Sutherland 1963, 130ff.), then we can conclude that he had brought in consequently the properties of manual graphical interfaces in his technical graphical interface *Sketchpad*.

3. Scripts and Diagrams as Auto-Interfaces

In the last part scripts and diagrams shall be introduced as “auto-interfaces”. That means they enable the interaction of an individual with him/herself. This can be understood as a special

¹⁹ Ivan Sutherland, e-mail conversation with the author, November 21, 2014.

case of a human-human-interface, in which two participants are united in one person. Moreover, scripts and diagrams can be described as auto-interfaces, because they are also “symbolic machines” (Krämer 1988, 3), thus interfaces to themselves.

With scripts and diagrams, I want to claim, we can influence and control our thinking and thus the creative process. Referring to this, the consideration of three practices are of significance: First, the production of new artefacts with writing or drawing. While doing so a necessary “transcription” (Krämer 2005, 43) happens, to externalize inner thoughts; secondly the “re-reception” of existing artefacts when reading or viewing them. It enables the repeated internalization of represented, especially own issues. Thirdly, the operative use of existing artefacts. Scripts and diagrams can be operated in a symbolic manner, for example by adding or modifying elements (as already mentioned).

Let us go now more in detail: Externalizing thoughts means to sort and to bring them into the specific order of a medium. With a view to diagrams it has been said that in the production procedure happens a “synthetic condensation or compression” of knowledge (Bogen and Thürlemann 2003, 8). We can understand this better looking at two historical examples: While Luca Pacioli's *Tree of Proportions* shows the connections between objects of mathematics, the *mundus-annus-homo*-diagram stimulated by Isidore of Seville offers a cosmological scheme for the interplay of world, man and time (Figure 5; 6). It becomes clear that a hierarchic tree diagram has a different order than an egalitarian circle diagram; in a tree diagram dichotomy and logical dependence predominate (Schmidt-Burkhardt 2009, 174ff; Lüthy and Smets 2009, 402)

With regard to speech and text and their chronological sequence it is – although it can be criticized – mostly spoken about a linear order (Harris 2005, 76; Raible 2004). It is a well-known phenomenon, that our thoughts will be

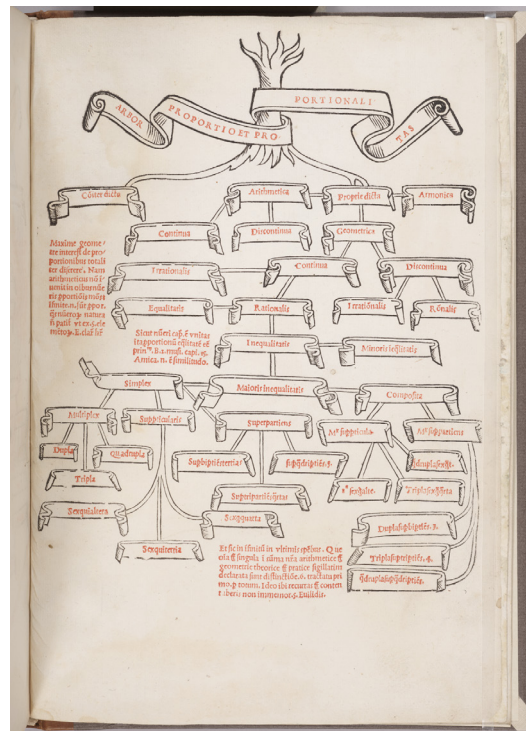


Figure 5. Tree of Proportions, in: Luca Pacioli De Divina Proportione (1509). Source: <http://www.maa.org/publications/periodicals/convergence/mathematical-treasures-de-divina-proportione-by-luca-pacioli> (13.10.2014).

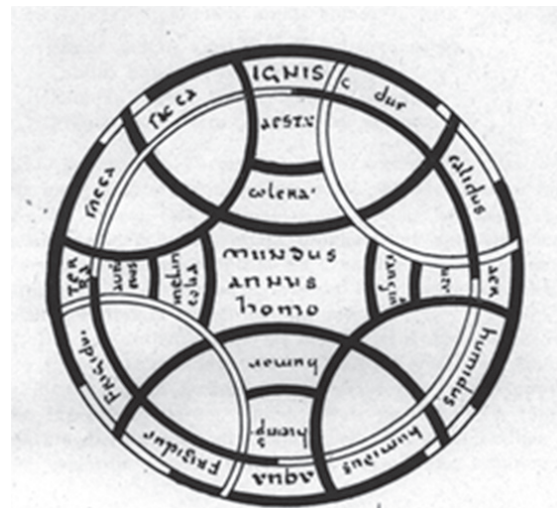


Figure 6. Mundus-Annus-Homo-diagram with 4 elements, 4 seasons and 4 temperatures after Isidore of Seville, remake of De natura rerum (kritische Edition). Source: Jacques Fontaine, Isidore de Seville. *Traité de la nature*, Bordeaux 1960, S. 216. Accessed: <http://www.uni-koeln.de/~ahz26/edition/ofon5gr2.htm> (13.10.2014).

concentrated, clarified and ordered by writing. When we formulate them, they become more precise. Existing thoughts will be modified or neglected and new ones appear. At the same time, it is possible to surprise oneself (Raible 2004, 200). Sybille Krämer makes a good note on this point: “Writing becomes a place of insights, a workshop and laboratory of our thinking, it becomes a forge for our thoughts” (Krämer 2005, 42) – (this also happened while preparing this paper). The fact that our “writing utensils” (“Schreibzeug”) (Nietzsche 2002, 18) work on our thoughts, said no other than Friedrich Nietzsche, using 1882 an early sort of a typewriter. To say it simply, a pen allows another flow of writing and thinking than a typewriter.

²⁰In such a material-based perspective, scripts and diagrams on paper are *tangible interfaces*, which own haptic surfaces, resisting when writing and drawing. One could say, depending on their support, they offer “touching-zones” (Hellige 2008a, 13), which let us interact with our own selves.²¹ That media could be described by their “user interfaces” or their “human interface” has been mentioned in media theory.²² Nevertheless, these graphical interfaces work not (totally) automated, humans are not machines. Once represented as a script or a diagram our thoughts can be *looked at* from outside. Similar to an inner monologue they allow (like in a diary) a kind of *talking to oneself* to check our thoughts, but they face us – after a while – more like statements of an alter ego or somebody else. It is not only meant, that thoughts leave the inner and enter it again after being transformed by a medium. We have to remember, media do not work neutrally when mediating, but create or at least transform the message due to their specific properties (Krämer 2008a, 67).²³ Moreover it happens, because the producer himself becomes the receiver. Even programmers forget over the years the meaning of written code. That way the producer gains a certain, critical distance and can reflect on his own thoughts

(Krämer 2005, 42). With Michel Foucault one could describe these practices of writing combined with self-monitoring and control intended to change the mind as “technologies of the self” (“Technologien des Selbst”) interlaced with “technologies of symbol systems” (“Technologien von Zeichensystemen”) (Foucault 2007, 289). Therefore the *producer* is entering a feedback-process. A popular effect is the self-correction when we talk and hear our own voice and recognize errors (Krämer 2005, 42f). The same happens when we read our own writings, when we do proof-reading. This can be seen in a manuscript from writer Fritz Hochwälder, in which the two procedures can be retraced very well, because of their splitting into manu- and typewritten (Figure 7). It becomes clear, that a literary text like *Der Himbeerpflücker* comes into being not only in a process of writing down thoughts, but also by its intensive revision on the paper. Theory of literature is speaking of brain workers and paper workers. It has been shown in detail with the example of Hubert Fichte, that writers use not only manuscripts, but also diagrammatic working drawings in their creative processes to organize materials, to develop a story and to find new ideas (Ortlieb 2008).

It was literary scholar Wolfgang Iser, who introduces the act of reading and comprehending a text, picking up Roland Barthes’s post-structuralist theory, as a process of interaction (Iser 1976, 38ff.), which was criticized because the text needs to become human-like for it, but results in the widespread belief, that “interactivity” is a property of media concerning their interpretation (Ryan 2001, 16f; GamesCoop 2012, 80f). Not only the text would be constructed while reading it. At the same time the text would control and touch the reader, by providing instructions for his ideas. Thus the work could be understood as a convergence of the interplay between text and reader. This means, the reception of texts and diagrams can start a

²⁰ It would have been interesting to take also the smart pen as an analogue-digital tool into account. Concerning the relationship of man and machine it was argued according to actor-network theory (Bruno Latour), especially with regard to the agency of digital tools, that interactivity had become more symmetrical (Seifert 2008, 9-14).

²¹ It would be fruitful to reflect the differences between the use of scripts and diagrams on paper and on a computer more detailed and link this up with the history of tangible interfaces.

²² *Lexikon Medientheorie und Medienwissenschaft: Ansätze – Personen – Grundbegriffe*, ed. Helmut Schanze (Stuttgart and Weimar: J. B. Metzler sche Verlagsbuchhandlung und Carl Ernst Poeschel Verlag GmbH, 2002), s.v. “Vorwort.”

²³ That the later reception of an own text is different to the process of writing it concerning the “(auto)-reflexion” and the self has been discussed more detailed (Giuriato and Stingelin and Zanetti 2008, 13).

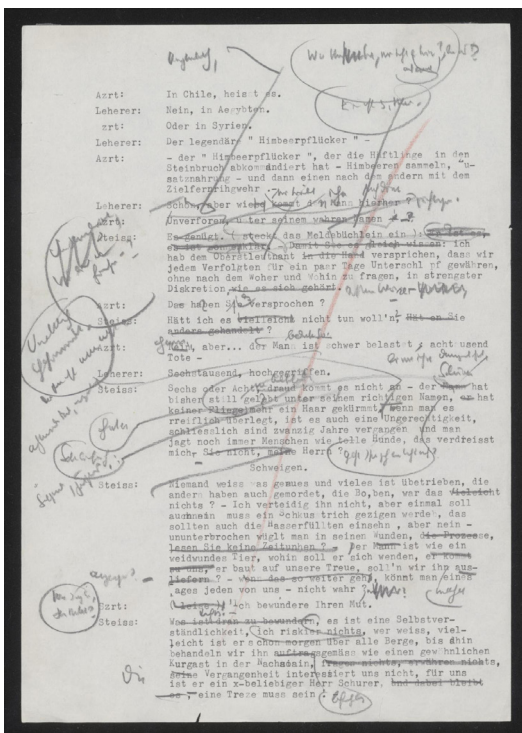


Figure 7. Fritz Hochwälder, manuscript of *Der Himberpflock* with his own remarks and corrections. Source: Wienbibliothek im Rathaus, Handschriftensammlung, Nachlass Fritz Hochwälder, ZPH 678.

revision of our ideas by comparing them with the ones represented. Actually, scripts are more than written language and diagrams are more than representations of structural issues. Diagrams are regarded as “cognitive tools” (Bogen and Thürlemann 2003, 10). And especially in mathematics it becomes clear: “This script is a medium and instrument of brainwork; it serves less for communication, more for cognition”, as Sybille Krämer explained and complimented: “The exteriority of scripture serves also for solving problems in a monologue-style” (Krämer 2005, 30f). Medieval diagrams of cosmology were given as examples for “media of thinking” (Bogen and Thürlemann 2003, 10). With a view to Charles Sanders Peirce, it has been exposed that, via diagrams, “movements of thought” not only could be slowed down and revealed, but also controlled; there is a talk of “discursive expansion” and “upfolding” (Bogen and Thürlemann 2003, 8ff.). Thinking could be lead in the right channels, when connection lines in diagrams would be followed and contained elements would

be related (Bauer and Ernst 2010, 62). These aspects have a certain tradition in the context of antique mnemotechnics and were described for diagrams at the latest since Aristotle (Yates 1966, 206). According to the so-called *method of loci* familiar rooms like those of palaces should be filled in mind with knowledge. Corresponding diagrams offer places on the paper where knowledge can be situated and linked with. This way of proceeding is ascribed to Metrodorus of Scepsis, who extended the familiar circle diagram with the twelve zodiacs (Figure 8), which are easy to remember, to create places where mental contents could be put down and associated with (Yates 1966, 40ff.). As an aside, artist Davide Bevilacqua deals with this in a media-reflexive manner in his piece *Memory Wheel*.²⁴ “Diagrams can control our accessing to memories”, Bevilacqua said, referring to Giordano Bruno, who suggested that combinations of symbols could be used for storing and recalling information in the human mind (Yates 1966, 199ff., 243ff., 308ff.). Again, zones are providing areas for meaning.

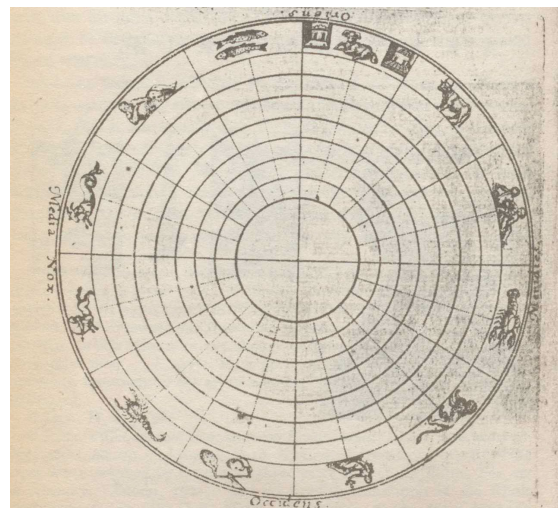


Figure 8. The extended Zodiac-diagram in a version of Robert Fludd (1612). Source: Yates [1966] 1984, 338.

²⁴ For more projects see also: King and Mignonneau and Sommerer 2008.

Let us now turn toward the aspect of operativity, which was already mentioned and is another reason why scripts and diagrams can serve for auto-interaction. They are not only static media: The represented knowledge cannot only *liquefied* in mind as demonstrated before. In this sense in Robert Fludd's circle-diagram is a kind of mechanical dynamics enclosed – one can imagine turning single circular rings. In fact, scripts and diagrams can also be operated. They allow an operating with symbols on their surfaces, thus they provide like human-computer-interfaces a “surface for operating” (Hellige 2008b, 11). They can be re-worked many times, not to say endlessly (Grube and Kogge 2005, 14). Words and passages can be deleted, overwritten or added. Using connection lines makes references between parts. All this Fritz Hochwälder's manuscript has impressively shown. Also diagrams allow the manipulation and re-arrangement of symbols on paper. For example in a tree diagram new connection lines can be drawn. In a mathematical matrix one can insert numbers and change them. Thus, diagrams are characterized with “configuration and re-configuration” (Bauer and Ernst 2010, 72).

And there is another kind of operativity: Scripts and diagrams can be equipped with an inner logic or a set of rules (for example a grammar). It fits in when diagrams have been described as combinatorial media (Bogen and Thürlemann 2003, 6) The number writing of mathematics shows, with numerals and operators like +, −, ·, : etc. controlled transformations can be done, for example when a multiplication is executed following certain rules. As with such scripts, they can be calculated quasi-mechanically, they are called “symbolic machines” (Krämer 1988, 3). Thus, scripts and diagrams – depending on the notion of “machine” – can be regarded also as a special kind of a human-machine-interface: They are auto-interfaces in the sense of an interface for themselves. When they offer a logical play with elements, this stimulates to try out things in a systematic manner. It is not a surprise, that diagrams have been not only described as tools for cognition, but also for cre-

ative processes and design procedures (Bauer and Ernst 2010, 17).

Conclusion

In this paper scripts and diagrams on paper were presented as interfaces. Even Ivan Sutherland's *Sketchpad*, which could be understood according to its engineers as a digital-technological implementation of hand drawing on paper, indicates drawing (complemented by pushing buttons) as an interaction with the machine. According to the reconstruction of its historical discourse, the term interface was understood less as a (technical) device, but more as a place, where actions for interaction can happen, which influence someone or something. In a first step, historical case studies showed that scripts and diagrams on paper were used as human-machine-interfaces. While the punch-card was suggested to be considered more a diagrammatic than a scriptural interface, the introduced computer system *Analyzing Reader* used written natural language on paper as input. In a second step, scripts and diagrams on paper were identified as interfaces in a group-communication like a learning situation. Finally, scripts and diagrams on paper were suggested to be auto-interfaces, arguing that they influence and control our thinking and thus ourselves. With the examples of writers it was demonstrated that artists use these techniques to access to themselves and to stimulate the creative process. With regard to the postdigital-discourse, it would be interesting to reflect in a next step also hybrid tools like the smart pen.

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