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Dynamicland

An ethnography of work on the medium*

Abstract: When research and development engineers attempt to influence the development of the computational medium by establishing concepts, finding new technical solutions and carrying out social experiments, they perform work on the medium (*Arbeit am Medium*). This paper analyzes an endeavor of this kind. It is based on ethnographic fieldwork conducted by the author between 2015 and 2017 in the "Dynamic Medium Group," an influential research collective based in the San Francisco Bay area. The research group, working under the lead of engineer Bret Victor, focuses on establishing the conceptual and technical foundations for a new "dynamic spatial medium." This paper explores some of the stances (including those of an autonomous form of engineering), ideas (including those rooted in media history and media theory) and forms of sense-making (including imaginaries of making history) at play in this type of endeavor. It highlights the types of conflicts and fault lines that emerged during the attempt to realize the project and how it was finally stabilized. This moment of stabilization emerged by focusing on a very complex prototype: *Dynamicland*, which is a hybrid of space and computer that links objects, things and people in new ways. The group built this prototype to explore the potential characteristics of a future medium. The members of the research group see *Dynamicland* as a prototype "from the future": A future imagined by them and made possible through their work on the medium.

Keywords: engineering, media, digital media, computer, ethnography

The *Dynamic Medium Group*, based in the San Francisco Bay area, is working on developing a fundamentally new digital medium.[1] Between 2013 and 2017, the engineers of this research group designed and built a "new kind of computer" called *Dynamicland* that served as the prototype for a new medium. My field research at their location was based on two goals: On the one hand, I wanted to learn something *from* these engineers who were looking into the nature of computers and media from an entirely different point of view than that of cultural anthropologists, com-

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1 Five of my eight months of field research were made possible thanks to a fellowship from the *Department of Communications* of *Stanford University*. I would also like to thank Paula Bialski, Wolfgang Hagen and Seth Schoen as well as all the members of the *Dynamic Medium Group*.

munications scientists and sociologists. On the other hand, I wanted to research *how* the potential features of a feasible new digital medium could begin to take shape in the work of these engineers; what intentions, expectations, social dynamics, and epistemic, technical, and institutional resources and limitations apply; and how concepts, imaginaries, technical systems, practices and organizational forms promote, stabilize, or undermine one another within this process. I will be presenting parts of this research in this paper, focusing on the enterprise of the engineers I studied, which I describe as "work on the medium." This paper is dedicated to the memory of Stefan Beck.[2]

Work on the medium

What exactly do we mean when we speak of a digital medium? At first glance, the answer is quite simple: Digital media are computer-based media. The relationship between computers and media, however, is complicated, not least because both terms are historically in flux (Hagen 1997). Computers are the result of a series of processes that culminated in the 1940s when various older fields of mathematical knowledge production, such as calculation and logic, were combined with new possibilities of the technical construction of complex circuits, leading to (1) electric machines that could perform calculations and allowed flexible instruction. In the following years, these calculating machines gained more capabilities of (2) storing, sorting, processing, representing, simulating and communicating information, and of (3) interacting with humans in more human-adequate forms. Consequently, (4) the features of older computers increasingly merged with other media characteristics to create progressively complex systems, (5) thus, establishing qualitatively new media characteristics, (6) new scenarios and contexts of their production and usage, and (7) an increasing influence on our society and culture (this influence goes, of course, both ways). If we are interested in examining this process (1–7) as a whole, it can make sense not to speak of (different) digital media in the plural but of a digital medium in the singular.[3]

The evolution of this digital medium continues.[4] One driver of this evolution is a certain type of research and development carried out by engineers, who aim

2 Stefan Beck not only actively followed these two scientific approaches, he knew like no other how to constructively employ them for an ethnographic "reconstruction of the logic of material, discursive, and symbolizing practices" (Beck 2000: 219).

3 I use the singular and plural here to refer to the relative specific nature of the argument: Digital media can be many different types of computer-based media, whereas a digital medium is the development that combines the features of computers and media as a whole.

4 At the same time, media theory experienced an upswing, especially in the works of Marshall McLuhan. This was not a coincidence. Although McLuhan developed his media theory without taking an in-depth look at computers, it is evident that his ideas and the subsequent development of media theory since the 1970s are based particularly on the experience of a (digital) media revolution.

to equip the digital medium with features that are substantially new and different from previous media (see especially element 5 in the last paragraph, but it also has implications for the elements 2–7). The work carried out by the *Research Center for Augmenting Human Intellect* (headed by Doug Engelbart) in the 1960s in Stanford and in the neighboring *Xerox PARC* industrial laboratory in the 1970s, especially in *Xerox PARC's Learning Research Group* (headed by Alan Kay) are important examples. In these labs, engineers consciously attempted to initiate processes for designing new features of the digital medium by employing a wild mix of speculative thought, new technical solutions and social experiments. While doing so, they investigated the question of what a digital medium is and could be – in Engelbart's case, without calling it a medium, and in Kay's case, naming it explicitly under the influence of Marshall McLuhan as such.[5] It is this type of work that I describe as "work on the medium."

The genesis of digital media is, of course, not only the result of the work of engineers and certainly not solely due to the specific type of research and development discussed here. The work of the research groups mentioned above, however, is indeed historically important, as it led to the development of inventions and imaginaries that had a significant impact, although they seldom had the effect the actors themselves had intended. This did not go unnoticed. On the contrary, journalists and authors of books on the history of technology have written extensively about these labs. It is indeed astonishing that the technical systems built at the *Research Center for Augmenting Human Intellect* and *Xerox PARC* closely resemble today's digital media (the problem of using these homologies to make ahistorical deductions to the effect that the work of these groups of engineers consisted of constructing the predecessors of today's media is another story altogether). The work carried out at these laboratories has now become a chapter in the story of how engineering was the motor for technical progress. The people active at the time were honored and personal testimonies have put them in the history books. Cultural anthropologists, media scholars and social scientists who are interested in digital media are delighted that engineers such as Doug Engelbart and Alan Kay are such congenial partners: Not only did they contribute to building systems, they also wrote brilliant articles that dealt with issues related to cultural anthropology, media studies and sociology, even though they treated them in a fundamentally different manner (Engelbart 1962; Engelbart and English 1968; Kay 1972; Kay and Goldberg 1977).

When, in the summer of 2015, I was presented with the opportunity to carry out ethnographic field research in a research group that followed explicitly in the

5 Alan Kay was inspired as a student by his university professor, the engineer Robert Barton, who was among the first to read and discuss McLuhan's work in engineering circles (interview with Alan Kay conducted by the author on December 12, 2017).

footsteps of Engelbart and Kay, I did not hesitate to accept.[6] My research project in the *Dynamic Medium Group* is primarily an ethnographic contribution to a corpus of monographs that otherwise deal more with the historical forms of work on the medium – an outstanding contribution in this area is Bardini's (2000) description of Engelbart's research group.[7] This special form of research and development has scarcely been examined ethnographically (e.g. Suchman 1987; Süßbrich 2005; Turkle 1984); there are, however, well-researched ethnographic research fields in its thematic proximity.[8] My field research took place from 2015 to 2017, including eight months on site.[9] This paper presents the initial results. It concentrates on the nature

6 I was not yet familiar with Bret Victor's work at this time, but I did know that the research context in which he was active had been initiated by Alan Kay, i.e. the engineer who had made conceptually significant contributions to the history of the digital medium in *Xerox PARC* in the 1970s. Even before I began my field research, I held Alan Kay in high regard as a representative of those engineers who criticized the state of contemporary digital media, because he believed that they do not achieve their full potential. At first, I spent time in several different research groups that worked closely with Alan Kay, but I soon focused my attention entirely on Victor's group, as their concept was the most radical form of work on a new digital medium.

7 Bardini (2000) demonstrates how the figure of the user was developed in Engelbart's group. See Friedwald (1999), Katz (2015) and Maxwell (2006) for more on Engelbart and Kay. Llach (2015) and Wagner (2006), for example, are also relevant for MIT, among other topics. Haigh, Priestley, and Rope (2016) provide a particularly subtle account regarding the quality of the historical reconstruction (however, the book dealt with early computer history). See, for example, Brand (1987), Hiltzik (1999), Levy (1984) and Waldrop (2001) for more on popular literature.

8 For ethnographic research on the production of media in industrial contexts and other related fields of application see the classical, quasi-ethnographic reports by Kidder 1981 (and later Latour 1987) and e.g. Downey 1998; Kunda 1992; Latour 1996; Malaby 2009; O'Donnell 2014; Star and Ruhleder 1996; Wittel 1997). Helpful is furthermore the ethnographic literature on the free software movement (Coleman 2013; Kelty 2008), on scientific research laboratories (especially relevant for this paper: Helmreich 2000; Knorr Cetina 2001; Rheinberger 2001), on socio-technological imaginaries (Jasanoff and Kim 2009: 120; e.g. Boenig-Liptsin and Hurlbut 2016) and on the subcultures of Silicon Valley (cf. English-Lueck 2002; Marwick 2013; Turner 2009; Zandbergen 2011).

9 In addition to my research journals, in which I documented primarily the work methods of the *Lab*, my sources were videos of public talks, which were particularly important for the early phase of the Lab; manifestos and self-promotions that are relevant for the later phases; prototypes and technical systems, including initial considerations and documentations that were developed in emails, on whiteboards and on posters; large sections of internal emails and Bret Victor's journals from 2013 to 2017; extensive open-ended interviews with all members of the research group (including members who left the group); the minutes of meetings and retreats, some of which were taken by members of the group and some of which I took; books and technical documents used by the group; research on historical references that made the rounds in the *Lab*; and discussions about the group's ideas with external partners. Conversations I had with my roommate, Seth Schoen, in San Francisco played an important role. It is generally important to note that ethnographic field research consists not only of collecting and analyzing data, but is also a lengthy process of comprehension whose most important stage takes place in the field. Consequently, the knowledge of what the engineers were preoccupied with – knowledge I acquired during my field

of the group's joint endeavor. My emphasis is, thus, on presenting the conceptual considerations of the engineers and their most important preliminary prototypes. Work methods and processes, forms of organization and internal conflicts, as well as the position of the group within Silicon Valley are only marginally discussed in this paper.[10] My objective in this paper is less to deconstruct and rather to reconstruct the engineers' ideas on the topic they *'are working on'* and the problems, solutions and work practices they develop in doing so – which is why I use the phrase 'work "*on the*" medium.'[11]

Dynamicland

On March 15, 2013, Bret Victor received an email from Alan Kay. It described an endeavor with an astonishingly ambitious goal, "pretty much tantamount to calling for a reinvention of personal computing itself" (Kay wrote in the email). Bret Victor, the recipient of this email, was 36 years old at the time. After studying electrical engineering, Victor built virtual-analog digital synthesizers for *Alesis* (a producer of electronic musical instruments) and then worked for several years for *Apple*, where he developed software prototypes for new hardware, such as for a new device that was later marketed as the *iPad*. Once Victor had left his job at *Apple*, he became a freelance developer,[12] but was in no way a blank page, as he had, by then, also written and given a series of highly influential papers on questions relating to new forms of information design. The author of the email quoted above, however, was even more famous than Victor: Alan Kay, who was 73 years old at the time, was the recipient of the renowned Turing Award[13] and had made important contributions to new ideas, prototypes and programming environments in the late 1960s and 1970s, all of which were aimed at developing a special version of the digital medium: the "dynamic medium" (Kay and Goldberg 1977: 31). This email from March 2013 was an invitation from Kay, the indefatigable, for Victor to help start a research group with

research, which was the basis for my analysis of the data – was the most important thing I brought back from the field.

10 See Bachmann 2018 for more information on the work methods and practices of the group and Bachmann 2017 for their position within Silicon Valley.

11 To a certain degree, work on the medium is a special form of the larger, more established research field of human-computer interaction (see Woletz 2016). However, Kay and Engelbart presented their most important work prior to the institutionalization of this field and almost all the actors described in this paper emphasize that their work was about more than just the questions and ideas discussed here.

12 This was the *Apple Cooperation's human interface device prototyping* team (interview with Bret Victor in the summer of 2017).

13 The *Turing Award*, which has been presented by the Association of Computing Machinery (ACM) since 1966, is widely considered to be the Nobel Prize of computer science. Kay received it in 2003 and Engelbart in 1997.

the goal of working on the medium. Instead of "one design, not one application," Kay had a bigger goal in mind, as he wrote in his email: "a 'rendezvous' and 'integration system' for 'things that help thinking, designing, creating.'"[14]

Six months later, Bret Victor's research group started their work. The group consisted of five to eight employees, but due to various fluctuations and because external friends also played an active role in addition to the employed members, more than a dozen engineers belonged to the inner circle.[15] In its first years, the group, alongside several other research groups initiated by Alan Kay, shared a large loft in the South of the Market District in San Francisco, the heart of the startup scene in northern Silicon Valley. Three years later, the group moved to their own lab in Old Oakland, on the east side of the San Francisco Bay. The entire research association started by Alan Kay was initially financed by the company *SAP,* and later by the research association *YC Research,* which is affiliated with the startup incubator *Y Combinator* and financed by donations from the industry. The changing financiers had virtually no influence on the group's work and Alan Kay also gave them freedom, true to his motto of supporting "people, not projects." The group's work was explicitly dedicated to fundamental research and not to the foundation of a startup. In this setting, the *Dynamic Medium Group* spent more than four years in a mixture of playful experimentation, software and system building, social experimentation and the search for a concept. During their earlier period, the group created hundreds of prototypes that initially indicated numerous possible paths their vision could take. My first visit was during this stage. Afterwards, a phase of severe crises on multiple levels took place, affecting both the group's goals and their forms of internal cooperation, which I partially witnessed on my second and third visits. The outcome was that the group focused its work on constructing a complex and technically demanding system for a place called *Dynamicland*, which began to take shape after four and a half years in Oakland. My final and longest visit took place during this phase.

So, what was this *Dynamicland they were building?* The group's first answer has always been that it is not possible to explain it in words or pictures: on the one hand, because it is something so new that people need to experience it for themselves; on the other, because it was built as a system that is bound by its location and space. In order to spare the readers from traveling to Oakland, I will, however, attempt to

14 Kay's email, which was very important for the Lab, was shared with me at a later point in time (as well as the majority of the internal emails of the group).

15 In addition to Bret Victor, the group members were: Glenn Chiaccheri, Chaim Gingold, Toby Schachman, Robert Ochshorn, Michael Nagle, Paula Te, Virginia McArthur, Josh Horowitz, and Luke Iannini. Additional important people connected with the group included May-Li Khoe and Dave Cerf. Throughout the paper, I have used people's real names because the group's specific and prominent ideas and work methods are hard to anonymize.

describe *Dynamicland*.[16] In the summer of 2017, the Lab's visitors would enter a large loft that had evidently been recently renovated expensively. Above the front staircase hung a banner with the word "*Dynamicland*" in colorful quilting, sewn by the mother of one of the engineers. The loft was divided into several large rooms. Part of the largest room was filled with a big, open kitchen containing a kitchen table made from a huge, old wooden board. Aside from this, the room was full of desks, display panels and prototypes. The second room was similarly furnished. These two rooms looked very much like many startups in Silicon Valley. The other rooms contained machines, tools and a well-equipped library. In the summer of 2017, visitors were first led into the open kitchen. There they were introduced to a few of *Dynamicland's* special features. The fact that this took place with the visitors standing around the kitchen counter – the same counter the research group usually used to prepare their meals – was, of course, intentional.

In addition to the kitchen utensils currently in use, several pieces of paper, some spread out all over, some sorted into binders and boxes, sat on the counter. All these papers had five colored dots printed on each of their four corners and several lines of code in the center. More importantly, colorful shapes, lines, images and videos were projected onto these papers. Glancing up, visitors could see a projector on the high ceiling above the kitchen, with a camera mounted next to it. The camera's function quickly became evident when visitors moved the sheets of paper: The projections moved with the pieces of paper so that the images continued to be projected onto them in their new position. There were also projections between the sheets of paper, which adjusted their positions when the pieces of papers were shifted. Small balls of rubber clay had the same effect, but they did not have any dots on them; evidently, they operated differently. When visitors flipped through one of the binders, each of the papers in the binder prompted the corresponding projections to appear, which were usually aimed directly at the binder, giving it the appearance of a dynamic book. Many of the projections represented simulations that could be manipulated; they often dealt with mathematical and physical subjects, such as particle movements. The whole setting had a playful mood and, despite the evidently complicated technical installation, a low-tech character, at least when compared with the bright demos that are normally expected from engineering laboratories.

In the next hour, visitors were greeted by ever-changing variations of the same nature in other locations inside the lab: Desks, a wall, a white rug and even the big kitchen table were all laid out with the same sheets of paper, as well as cardboard structures and other arts and crafts materials, often decorated with colorful dots and projections. Visitors encountered installations of a different kind in some places in

16 The following is a description of *Dynamicland* in the summer of 2017 told from the point of view of a visitor in order to give the reader a first impression of the building. These visits occurred often and were, to some extent, standardized.

the lab: They could, for example, operate a pinball machine made of light and paper, magically move Go stones made of clay on a table using a joystick or draw pictures of projected light on a wall using lasers – all of these, the visitors were told, were older prototypes that members of the group had built before *Dynamicland* began to take shape. Hundreds of small photos of similar prototypes were displayed in a research gallery spread out over several display panels. If a laser was aimed at these photos, videos and historical emails appeared that documented each of the prototypes (the research gallery for older prototypes was also a prototype of its own from an older generation). There were a striking number of the papers with colorful dots on one wall – visitors were told that they together formed the operating system that controls *Dynamicland* (more on this later). In another spot, posters, which, despite their very large size, were indeed posters, hung on the walls. These posters usually contained technical concepts, often in microscopic writing and in a peculiar layout. Other posters showed huge drawings of people, who were evidently having a great deal of fun in an advanced future version of the current *Dynamicland*.

As you are starting to (hopefully) imagine, *Dynamicland* was a large loft filled with prototypes, including some that were made of papers with colorful dots on them. The members of the research group worked in this loft, but, at the same time, it was equipped for receiving guests and giving them a tour. Visitors usually toured *Dynamicland* together with a member of the research group who, at first, did not comment on anything that could be experienced in the room. Visitors who stayed a while longer learned how the sheets of paper could be inspected, programmed, and printed and often used them to build applications of their own, which were then left for future visitors. Eventually, the conversation almost always turned to the question of how to describe in words what was going on. While visitors searched for the right words to describe what they were experiencing, members of the research group had already prepared their own. The canonized self-description of *Dynamicland* was then handed over to the visitor in the form of a newspaper called *Zine*, which the group had written together. *Zine* contained a condensed form of the research group's conceptual considerations, so perhaps it makes sense at this point to end our imaginary tour, and to take a look at this *Zine*.[17]

The sub-headline of this publication described *Dynamicland* as a "place for all people to build, study, play, speak, learn in fundamentally new ways." This was followed, somewhat roguishly, in brackets by "(also it's a new kind of computer)." This ambivalent description – on the one hand a specific "place," and on the other, "also," a computer – was, of course, just as conscious as the placement of the papers

17 Until the summer of 2017, the group avoided exposing *Dynamicland* to the online public as much as possible. In January 2018, the group put the website online as part of their search for funding. The content of the website was similar to that of the *Zine* but had an additional focus on the concept of 'community': dynamicland.org, accessed on February 2, 2018.

on the kitchen counter. The result of this hybrid of a place and a computer was, according to the *Zine*, initially a "computer with no box" that could be spread out over the space of the room: "People walk around inside of it." In this "real place," "real objects in physical space" would assume the role of "virtual objects on a screen." Visitors could, therefore, experience something that was a "part of our shared physical reality, not an illusion on a screen."[18] At the same time, the *Zine* emphasized that it was important to the founders to keep the hybrid they had created fully programmable: Similar to free software, *Dynamicland* gives all its users complete access to its system (i.e. it is not limited, such as on a smartphone or an app store). In this way, *Dynamicland* provides people with tools they can use to create their own tools and, thus, truly develop a "fluency in a medium."

In addition to the double characteristic of *Dynamicland* as a place and a computer, the title of the magazine also referred to even bigger goals: *Dynamicland* was intended to explore a "fundamental[ly] new way" to understand, express oneself and communicate. It also aimed to support "togetherness" in much better forms. All this made *Dynamicland* a prototype for a "fundamentally" new medium: The "dynamic spatial medium." As a "spatial medium," it was not only "more real," but also "more human-scale." As a "dynamic medium," it was also equipped with all the abilities of a computer: One example was its programmability, another was the ability of computers to model and simulate systems. While the medium could only be hinted at in *Dynamicland,* the project itself was an attempt to initiate and influence the development of this medium. If it managed to develop and establish itself within the next few decades, it could have the potential to start a revolution similar to that of personal computing and/or the internet (if we think small), or, if we want to think bigger, could possibly be as impactful as printing or even the written word, the mother of all media revolutions.

All of this was pretty hard to digest, even in Silicon Valley, which is not exactly a stranger to big promises. How did all this fit together: a system that projects light onto a few pieces of printed paper, on the one hand, and such gigantic promises, on the other hand? How could it be that visitors, including many prominent figures in Silicon Valley, did not break out in laughter, but often became keen supporters of the project? Bret Victor's prestige certainly plays a role in this, as does Silicon Valley's questionable mantra that engineers can "make the world a better place" (Winner 1986, Barbrook and Cameron 1995). But this, alone, is not a sufficient explanation. In order to comprehend what was going on here, we must understand what the research group was talking about when its members used the term "medium", and we must take a closer look at *Dynamicland* itself. I will begin with the former.

18 In doing so, the group distinguished itself from related approaches, such as virtual or augmented reality.

Ideas, stances, sense-making

To analyze the ideas, stances and sense-making processes behind the *Dynamic Medium Group's* work on the medium, I will now examine a series of talks held by Victor before and after the foundation of the *Lab*, i.e. several years before *Dynamicland* began to take shape. A special role has a talk called "Inventing on Principle", which Bret Victor held on January 20, 2012, at the Canadian University Software Engineering Conference (CUSEC).[19] This was Victor's most famous talk, which is reflected in more than 800,000 views on a variety of video platforms (a high following for an intellectually challenging 54-minute talk). The power of the talk also became clear to me through stories I heard about the effects Victor's video documentations could have on engineers. One engineer, for example, who later worked in the *Dynamic Medium Group*, told me in an interview[20] about the moment, years before, when she watched this video during her lunch break at work after a friend had recommended it (she did not know yet Victor at that time): It had brought her to tears and shortly thereafter, she decided to go back to university, partly because of this experience. Other engineers in the group reported similar moments of awakening.

So, what was Victor talking about? Similar to all of Victor's talks from the period before founding the *Lab*, he showed "demos" (i.e. demonstrations of certain software prototypes) of new kinds of digital information design. These demos were accompanied by introductory and concluding remarks. In "Inventing on Principle," Victor made in these framing remarks an appeal for an uncompromising form of what it meant to be an engineer. Engineers should place their work in the service of a principle and not in the service of clients, university careers or dreams of becoming rich. Such a principle should be just as special as it is difficult to realize. It should not be about fulfilling general goals, such as user-friendliness, but instead provide new perspectives for the work and, thus, bring "new ideas into the world." In his case, he described his principle with the phrase "creators need an immediate connection." By this, he meant that further developments of dynamic computer interfaces should give users more direct and extensive feedback. The exclusive aim of all his demos was to explain this principle. The important aspect was the principle, not the demo. Consequently, his talk did not recommend that other engineers follow his principle; instead, he advised them to make their own – which is why the talk was titled "Inventing by Principle." The talk mentions some of the first elements that would later be a part of *Dynamicland*: An uncompromising stance, framing the engineer as a principled hero, and a set of ideas on how software should be further developed to increase the creative power of its users.

19 vimeo.com/36579366, accessed on February 2, 2018.

20 Interview on August 18, 2017.

One thing, however, was missing in this talk: The medium. It had its big appearance more than a year later in a talk entitled "Media for Thinking the Unthinkable," which Victor held on April 4, 2013, at the *MIT Media Lab*.[21] Again, Victor showed a cascade of demos accompanied by one argument, which was now explicitly rooted in media theory: "[S]cience" investigates systems, "engineering" builds them, but one thing both have in common is that they have to understand systems. Understanding, however, is shaped by representations made possible through media. Victor defined representations as "how we think about [something]" and media as "thinking tools."[22] He claimed that our thinking is still shaped by paper and pen, even where computers have taken over their functions. Programming languages written with a keyboard, for example, are still under the media paradigm of paper and pen, and are, as such, unsuitable for the pending tasks of science and engineering. However, he stated that engineers have the opportunity to develop new thinking tools that could fully tap the possibilities of computers and be a powerful aid for understanding and building complex systems. His demos are trials for a project of this kind. This talk was, therefore, a variation of Victor's personal principle, which he had presented in the previous talk, but now it was reformulated from the perspective of media theory. Victor's principle was no longer one of many; it had become *'the'* king of principles. At the same time, Victor's version of work on the medium became a kind of metawork for all future knowledge work.

Almost fifty years earlier, Alan Kay had followed a similar line of argumentation. And it was precisely Alan Kay who had written the email discussed earlier, eleven days after Victor's talk, asking Victor to launch and head a new research group. Victor agreed and began recruiting engineers. During this phase, Victor held a talk entitled "The Future of Programming" on July 9, 2013, at the DBX Conference.[23] Victor appeared in strange clothing. He wore a starched white shirt with several pens in his shirt pocket and a thin tie, i.e. not the laid-back clothes that one would expect from a Silicon Valley engineer from the 2010s. An overhead projector stood next to him. By the time the first slide appeared, the audience realized that Victor was playing the role of a historical engineer who was speaking on July 9, 1973, about the future of programming from this (past) point of view. The engineer Victor was playing then presented a series of scenarios that he described as absurd and which he believed would, therefore, not come into being. But these scenarios

21 worrydream.com/MediaForThinkingTheUnthinkable, accessed on February 2, 2018.

22 Victor refined his reasoning on media theory in a later talk, "The Human Representation of Thought," (cf. below). Representations became methods of presentation that can be found in thinking tools, where they determine ways of thinking. He now understood maps, tables, writing or music as representations. New representations are, therefore, something he attempted to include in his original approach. However, ways of thinking, methods of presentation and thinking tools cannot be clearly distinguished from one another.

23 worrydream.com/dbx/, accessed on February 2, 2018.

described precisely the historical developments that later, in fact, occurred. Instead, the fictive engineer of the past voiced recommendations that implied a form of work on the medium which would continue what has been done until then (i.e. prior to 1973) in terms of its radicality and vision. This work pointed, not surprisingly, not into the direction of what actually happened, but towards the current perspective of the real Bret Victor. In short: Victor was now placing himself directly in the footsteps of Engelbart and Kay. This gave him authority and significance, but it also had the dangers inherent in the status of a disciple. Consequently, Victor developed a specific version of this tradition. Instead of following in the tradition of the technical solutions connected with the names Kay and Engelbart, he mobilized a more abstract tradition: Work on the medium.

In the next year, Victor explained in two additional talks – "Seeing Spaces" at the EG Conference on May 2, 2014, and "The Human Representation of Thought," which he held in October 2014 at the UIST and SPLASH conferences[24] – what exactly this medium could be. Space and physicality, he said, need to play new and different roles.[25] Only a spatial medium would free people from the permanent "peek-a-boo" game in front of their screens, where they only had direct access to small parts of a large complexity – a condition that forces them to imagine the rest without the support of a thinking tool. Victor, thus, abandoned his hopes for the development of a screen-centered computer, as these "tiny rectangles" stood in the way of new ways of representation and thinking. Instead he started to imagine what, years later, the research group would call the "dynamic spatial medium." Victor's ideas had become even more radical. At the same time, they had also become more theoretical: While all the talks Victor held prior to founding the Lab always contained demos – for a good reason, since engineers seldom trust what they cannot see in its concrete state – the talks that came afterwards had to make do without demos. Instead, Victor used theories and drawings.

Consequently, Victor did not have anything left to show except radical ideas. And what he wanted to create – a fundamentally new thinking tool – was not something he could build alone. Victor recruited a team of younger, highly talented engineers, all between the ages of twenty and thirty, many of them with a background at MIT, and all enthralled with Victor and Kay's ideas and the promises that these ideas contained. In the first two years of the *Lab's* existence, this resulted in a

24 You can find "Seeing Spaces" here: http://worrydream.com/SeeingSpaces/and "The Human Representation of Thought" here: vimeo.com/115154289 (both accessed on February 2, 2018). UIST and SPLASH are conference series by the "Association for Computing Machinery." UIST is the symposium on "User Interface Software and Technology" and SPLASH stands for "Systems, Programming, Languages and Applications: Software for Humanity."

25 Here, Victor was able to refer to his previous work on the role of using our hands, cf. "A Brief Rant About the Future of Interaction Design" from the year 2011: worrydream.com/ABriefRantOnTheFutureOfInteractionDesign/, accessed on February 2, 2018.

productive phase in which many prototypes were developed. The younger engineers often combined Victor's older principle of "creators need an immediate connection" with their own ideas. However, as a result, the younger engineers were most of the time writing software for the creation of software. In addition, the members of the group created prototypes for a spatial medium, but these prototypes were still far away from being a new thinking tool. Victor felt none of this was going far enough. He was growing nervous and unhappy and increasingly showed this in the *Lab*. The situation grew even tenser when Victor adopted an engineering method called "bootstrapping" that Doug Engelbart – one of the key proponents of the particular tradition of work on the medium that I am describing here – had developed 50 years earlier.

Engelbart had wanted to create an "augmentation system to provide increased capability for developing and studying augmentation systems" (Engelbart and English 1968: 396). Victor was not only interested in Engelbart's conceptual considerations about the idea of "augmentation systems," which resembled his own, "to boost collective intelligence and enable knowledge workers to think in powerful new ways," as Victor wrote a few years earlier in an obituary for Engelbart.[26] Victor was also no longer solely interested in the uncompromising stance with which Engelbart followed his ambition "to collectively solve urgent global problems" (Victor in the same obituary). Victor was now also increasingly interested in Engelbart's methodology, namely in his "interesting (recursive) assignment" (Engelbart and English 1968: 396) to his own research group that Engelbart called "bootstrapping". In this assignement Engelbart asked his research group to build a system that the group would then use to build the next iteration of the system (a process that can be repeated), leading to an evolving collective of technology and humans, and an evolution of language, methods and knowledge in the research group. Victor wanted to attempt something similar, but with a spatial medium. This meant that all of the engineers had to build (t)his spatial medium together, and, while they were doing this, they should use, as much as possible, the evolving medium they were working on, thus banishing from the *Lab* that ever-present work in front of screens that Victor increasingly hated.

But all of this was highly controversial in the *Lab*. Many of the younger engineers felt they were being degraded to being merely assistants. At the same time, Victor's view of the world became darker and, as a result, his ambitions became even greater: A new medium would have to help "prevent the world from tearing itself apart," Victor wrote in an internal email to the research group in the summer of 2016. It is probably no coincidence that this further radicalization happened while the political situation in the US darkened. At the same time, it was an attempt to

26 worrydream.com/Engelbart, accessed on February 2, 2018.

find even stronger arguments to encourage the younger engineers to assist him in his project of jointly building a prototype for a dynamic spatial medium. However, this very argument made the situation in the *Lab* even more delicate: Many of the younger engineers doubted whether work on the medium could achieve goals of such kind. As a result, some of them demanded that Victor abandon these enormous ambitions, while others accepted them but wanted to realize them in a different way: Either by developing different media or using means that had nothing to do with media at all. Victor grew even more desperate: He was unable to assert himself within the group, and he believed that his external prestige was suffering because he still had nothing he felt he could show for his work. All the prototypes were either for something other than a spatial medium or were so sketchy that he did not think they had the necessary features to substantiate his ideas and authority.

Along these lines of fracture, a series of conflicts broke out during which most of the first generation of engineers decided to leave the *Lab*. Victor hired a second generation. Once more, conflicts broke out, and once more, they broke out around similar lines of fracture, but, in time, a fragile compromise was found. An important factor was that Victor now permitted – initially to a large extent against his beliefs – the new spatial dynamic medium to have more objectives than just establishing new ways of thinking. A new objective was to promote new types of "togetherness", not only as a means for common understanding, but as a goal on its own. The research group also prevailed with their wish of involving other users outside of themselves, such as kids. The group increasingly started to speak of themselves as a "community." These compromises remained fragile, but they were sufficient to enable the group to work together on an especially demanding part of their endeavor: the construction of a technical system that would finally be a prototype for exploring a dynamic spatial medium, a bootstrapping system that would shape their work, and a demo for the principle-driven stance of the group and the newly achieved compromise regarding ideas and sense-making processes. The group began to build its "new kind of computer":[27] *Dynamicland*.

Things, objects, people, future

Dynamicland is the name for the room-sized prototype for a hybrid between a place and a computer that I described at the start of this paper. I now want to focus on it a second time. How did the many colorful sheets of paper lying across tables and other

27 Once again, the group experienced various crises, but these were more due to the building of the system: concepts were rewritten, technical solutions debated, different programming languages used, forms of cooperation tested, and deadlines missed. But in May 2017, the operating system was functional for the first time. Several months more were needed to make the system quicker and more stable. In the summer of 2017, a status was reached in which the system was truly usable.

surfaces turn *Dynamicland* into a computer that could serve as a prototype for a new medium? In order to answer this question, we need to understand how *Dynamicland* related things, objects and people to one another. I will begin with the objects. Each of the dotted papers in *Dynamicland* corresponded to what the "object-oriented programming" (OOP) paradigm calls an object. Many programming languages used today employ versions of this paradigm. In these common programming languages, however, objects are not physical things such as a piece of paper. Objects in the OOP paradigm are self-contained units of code and data. These virtual units are presented in the OOP paradigm as objects because they are, to a certain degree, capable of acting autonomously, communicating with other objects, and nesting in one another by creating classes (the focus differs depending on the variation of the paradigm). I would like to emphasize this point again: Objects in OOP are normally just a method of organizing large amounts of code through systemic modularization; they are not physical things.[28]

Dynamicland, on the other hand, aimed for a "strange and wonderful mix of computational and physical material" (according to the *Zine*) in which (some) things are also objects and (all) objects are also things. This required a series of operations. A system had to recognize the physical things by, for example, 'seeing' them and conducting a visual analysis to identify them (which explains the dots that are simply color codes for numbers) and it had to analyze some (not all!) of the features of these things, such as their position in the room. In order for physical things to become virtual objects in the sense of the OOP paradigm, the system also had to be able to carry out a series of additional operations: It had to know, for example, what the objects can do and should do, and it had to be able to control the complex interrelationships that emerged as a result. In particular, the central components of the system, which transformed physical things into virtual objects, should consist of precisely those physical objects that it had to recognize. This meant it first had to make itself possible (an advanced but not entirely unusual characteristic of a software system). In *Dynamicland*, all of this was made possible thanks to an operating system called *Realtalk*, which the group had developed for this purpose.[29] The group later described this system in their *Zine* as follows: "Any physical thing can be an object, as long as some other object claims to recognize it. Any physical thing can

28 In order to fully understand this, it helps to reconstruct it from the context of programming languages and environments (I have used a very simplified description here of what actually occurs). Programming languages and environments must contain mechanisms that can formally instruct machines, but they are also intended to be comprehensible for people.

29 The name *Realtalk* is a reference to a hybrid of the programming language and environment called *Smalltalk*. It was developed in the 1970s in *Xerox PARC* by Alan Kay, Dan Ingalls and Adele Goldberg, among others (Kay 1993). *Realtalk* adopted some of the concepts of *Smalltalk*, but mostly it functioned differently.

be a 'program' (whether it is a page of text, a diagram or a pile of stuff on a table), as long as an object claims to have interpreted it."

All this was realized in Dynamicland's current iteration by cameras and conventional computers. However, at least in principle, it could be achieved by any kind of sensor technology. After all, it was merely a supporting framework for a combination of physical objects that could recognize and influence one another. The result was a physical environment that contained a subset of things, whose features that turned them into objects were accessible for people and other objects alike. In other words: This subset was accessible for other objects without becoming inaccessible to humans. The *Zine*, once more, explained that: "[Realtalk is] designed to be examined, understood and modified, with no barriers of 'black boxes' (…) if a person can't see something, Realtalk can't see it either!"

In *Dynamicland*, people could manipulate things in a variety of ways. Firstly, they could be in the room together and manipulate physical things without the system being aware of it. They could, for example, draw a few lines to constitute a playing field on the floor. That may seem trivial, but it was important for the engineers, because *Dynamicland* was purposefully designed to allow those things that can be done without a computer to be done so. The credo was that computing should be reduced, wherever possible. Drawing a line, in this example, could be done just by drawing a line – it needs no computer. Secondly, people could manipulate features of physical objects which were recognized by the system. People could, for example, move objects back and forth in a game, thus, changing their positions in space. Thirdly, people could write programs that controlled these objects and their interrelationships. To do so, they placed another paper object, called the "editor," next to the first. The editor adopted the program from the object that was to be reprogrammed and enabled its manipulation via keyboard and projection. If users were happy with the changes, they could print a new object and replace the old one with it.[30] In addition, users, i.e. visitors to *Dynamicland* and members of the research group, could associate an object with files, streams or other data, projecting, for example, an image or a video onto the object, or linking it to a certain sound.

Anyone who used the system also developed its features. Most of the time this was a new application: A new game or new way of representing a system. People often took advantage of the option of spreading the objects out throughout the room. Users often experimented with new kinds of manipulation, for example by integrating robots. And sometimes, people also changed fundamental system features, although this was done less. The system did make thinking and comprehension easier in some areas, especially when the group built new iterations of the operating

30 The research group dreams of finding solutions in the future in which the manipulation of code and the physical manipulation recognized by the integrated system of other objects become one and the same thing, enabled by interfaces that replace language-based programming.

system and used the possibilities inherent in this process (remember: the central features of operating system were built in itself, that is: they were built by using the same pieces of paper that were recognized by it). However, it was new ways of togetherness that became increasingly the most important features of *Dynamicland* to many members of the group. This was already apparent during the joint building of the system but became clearer when the first iterations of the system were applied to build additional applications. When several people worked with the system, *Dynamicland* produced intensive and unusual forms of social interaction. The applications were in close physical proximity to one another and interconnected with one another. People inspected the objects made by other users and copied and altered them. Relaxed and playful cooperation was the dominant form of social interaction, and I was not the only one who had the feeling that potential traits of a new medium were, indeed, emerging here.

At this point, I have come full circle: The mixture of physical things, virtual objects and people leads us back to the ideas, stances and sense-making processes that were integrated into this mixture. This wild combination was situated in *Dynamicland* as it had become in the summer of 2017, but it was also situated in the past in the form of an imagined trajectory of work on the medium that pointed to *Dynamicland*, and in an imagined future, since *Dynamicland* was, to borrow the jubilant phrase used by the research group, "from the future." *Dynamicland* was a prototype: A special form of an "epistemic object" (Rheinberger 2001: 24), a "working artefact" (Suchman, Trigg, and Blomberg 2002: 175, 391) and a trap for potentialities (Jiménez 2014), intended to catch a medium of the future. The medium of the future was what science studies describe as the "epistemic object" (Knorr Cetina 2001: 181): Objects of investigation that have not yet fully taken shape.[31] This ambiguous epistemic object (which should not be confused with the objects in *Realtalk*)[32] was a preliminary, unstable and future-oriented abstraction of previous engineering practice. It was a prototype that would allow other prototypes to materialize. *Dynamicland,* therefore, existed in a "not-yet" status; it was its own forerunner, a materialized promise. In the imagination of a recursive methodology

31 Epistemic things (generally speaking: The means of research that shape the process) and epistemic objects (generally speaking: The desired outcome of the research process, which unfolds during this process) differ within the context of science research. In our case, situations become either the one or the other, depending on the perspective. The medium of the future, for example, is the epistemic object of the entire process. At the same time, it is also an epistemic thing of the future. In the case of bootstrapping, for example, it is also intended as an epistemic thing of its own development. Throughout the process, there are inherent challenges at each of the stages, including technical problems, particularly those whose solutions become epistemic objects at the corresponding stage.

32 The same applies for Rheinberger's epistemic things: These, too, cannot be equated with *Realtalk's* objects.

of "bootstrapping," features of the burgeoning medium should contribute to its own evolution through self-referential, positive feedback. The technical solutions of *Dynamicland* were meaningful (and only meaningful) within this context of a medium of the future. Once their own practice revealed the first signs of what the group had been searching for, visitors and the engineers interpreted them as proof of the success of the entire endeavor.

Conclusion

No one can know whether the *Dynamic Medium Group's work* on a "dynamic spatial medium" will have an impact similar to that of Doug Engelbart or Alan Kay's work. Only one thing can be said with certainty: The aim of the *Dynamic Medium Group* is to work on the medium itself. Stances, ideas and sense-making processes play an important role in this work. In the case of Bret Victor and the *Dynamic Medium Group*, their stance was shaped by the ideal of principled autonomy for the engineer, which contained a tendency toward radicalization. As a result, conflicts arose. Once these were resolved, the group was able to work together to build a complex prototype following an earlier phase of extensive, individual work on a large number of prototypes. *Dynamicland* became a combination of space and computer connecting people, things and objects in new ways. From the group's perspective, *Dynamicland* is a prototype and demo for the "dynamic spatial medium." *Dynamicland*, thus, became an essential part of their endeavor without which all the group's stances, ideas and sense-making processes were little more than empty speculation. On the other hand, Dynamicland can only be fully understood if we take the group's stances, ideas and sense-making processes into account. If one is willing to do so, it is indeed possible to see *Dynamicland* as a preview for a fundamentally new medium. As such, it stands in tangible contrast to everything that we consider to be normal for digital media. Whether it is smartphones, social networks or virtual reality glasses, they all start to feel incomplete and sad, if seen from the point of view of a future that *Dynamicland* aims to foreshadow and construct. Viewed in light of the materialized media Utopia of *Dynamicland*, our present times urgently need work on the medium.

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