Patterns of Practice – Interdisciplinary Negotiation of Cultural Complexity through Practice-Based Methods in Informatics

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Abstract

Complex target domains, such as cultural environments, necessitate an interdisciplinary approach towards system prototyping. At the same time, few methodologies exist for productive interrelation of constructive efforts within applied computer science and the reflexive practices of social research and the humanities. Following the principle of *knowing through making*, this thesis discusses development and application of a practice-based methodology for construction of digital artefacts within cultural contexts.

On the level of theory, it substantiates the Practice paradigm within Human-Computer Interaction through a reading of Actor-Network-Theory as a practice theory. The developed methodology allows for interdisciplinary practices of joint digital artefact production to unfold in the face of antagonistic theoretical commitments. Constructive efforts are methodologically controlled through recourse to established criteria of rigour in practice-based research.

Validity of the methodology is demonstrated during the course of three practice-based making projects: In the course of the first project, an interactive installation is developed, allowing users to experience biographical narratives in pairs of two. Realised via full-body tracking, it facilitates negotiation of questions regarding identity and performativity. The second project concerns itself with development of a tangible user interface to be employed in museums. Constructive efforts within this project facilitated an exploration of the concept of digital materiality. Within the third project, a series of ambient information displays were created, based on algorithmic collage generation.

Prototypes developed are situated within an overarching prototype ecology, developed and refined in the course of empirical studies. Concerned with development of interactive artefacts for exhibition contexts, the discussed projects show how constructive negotiation of cultural complexity is possible as a process of digital artefact creation.

1
Introduction

From the times of their inception, computers were envisioned as universal devices. This dream seems to come closer to its realisation – within recent years, computing technology has been subject to an unprecedented proliferation. Computing systems now permeate nearly every aspect of human life, entering into everyday contexts, be they domestic, academic, or cultural in nature, thereby restructuring our domestic, professional and cultural lifeworlds.

These tendencies of universality and ubiquity in turn complicate the task of creating digital technology. As the range of possible contexts of use expands, the set of possible relationships computing artefacts are able to take part in multiplies. We have enabled them to relate to our heartbeats and brain waves, to correlate moods with movie recommendations, to link our habits with potential dating partners. They track our movements while computing restaurant recommendations, function as interlocutors when buying concert tickets or composing love letters. They connect us to employment agencies and accompany us during museum visits and hospital stays. We manipulate them during situations of boredom, intimacy, and desperation. Mobile digital devices have become constant companions which we possibly touch more frequently than our intimate partners.

This incredible diversity and inner complexity of situations of technology use frequently puts a high amount of strain on familiar computer science methods, which were devised in order to optimise technology interactions within comparably

structurable scientific or enterprise environments. Similarly, design processes aimed at development of consumer products, even if refined towards everyday contexts, might struggle to do justice to the autonomous nature inhering within cultural experiences on which this thesis will focus.

Designing for Cultural Spaces

Cultural environments such as museums or exhibition spaces pose a unique set of challenges for respective development processes. They call for users to pursue autonomous processes of self-cultivation[1]instead of introducing a heteronomous organizational agenda. At the same time, digital artefacts relate to an experientially rich set of preexisting objects and practices.

These complexities can be exemplified when reflecting on the role of an interactive artefact acting in the context of a museum visit. If the artefact becomes part of the exhibition environment proper, it can no longer be reduced to a functional or utilitarian role. It might contour experiences made earlier or try to provide impressions of its own. It offers information to visitors while colouring their experience of the space as a whole. It contrasts or blends in with other artefacts populating the space. It might evoke associations with other digital devices, such as smartphones, or try to avoid these. It might offer an online interface in order to directly interface with users' mobile devices or try to draw their attention away from the online world into the here and now.

Crucially, the way a digital device acts on visitors does not only depend on immediately perceivable exterior design elements but also on the way it processes and presents information, on its programming and mode of organising data. Resultingly, in order to see what a specific artefact "does" – how it relates to users' practices, how it shapes, facilitates and constricts their experiences – a variegated set of methods has to be applied.

Consequently, development of digital artefacts for everyday and cultural contexts is usually approached as an interdisci-

[1] The German language offers the concept of "Bildung": Respective activities are not limited to goal-oriented processes of formal training or education while neither being part of the undemanding sphere of entertainment and recreation.

plinary endeavour. Disciplines such as social research, computer science, anthropology, and media psychology are enlisted in order to supply knowledge of the social processes and practices technological artefacts seek to modulate.

This necessity for participating in interdisciplinary networks puts a high amount of methodological stress on both computer science and cooperating disciplines. Computer science has to process theoretical and communicative artefacts foreign to its disciplinary culture. It is forced to make sense of data produced through practices such as ethnography, situational analysis, and multimodal analysis, decipher communications framed within the terms of phenomenology, structural linguistics, or actor-network-theory: Ethnographic methods confront it with thick descriptions of computing artefacts' status within users' practices. Multimodal analyses provide explanations of how different forms of media disseminated by information systems work together in order to make meaning. Situational analyses map out relationships between social institutions, material artefacts, organizational procedures, and electronic infrastructures.

While all of these methods help to shape a nuanced account of the relationship between artefacts and social practice, the question of how to relate them to constructive activities is not immediately apparent. Social research and psychology in turn are confronted with the need to supply requirements analyses, user studies, and implications for design. Respective theories and methodologies are indebted to antagonistic theoretical commitments; necessary coordination processes are fraught with conflicts and misunderstandings.

In relation to cultural phenomena, on which this thesis focuses, computing practice runs a double danger: If it insists on traditional and familiar methodologies and disciplinary framings, it risks missing the specifics of culture, resultingly remaining insensitive to the intended target domain. Artefacts constructed in this manner remain as foreign bodies within cultural contexts, detracting from processes of cultural experience, education, and self-cultivation, rather than furthering them.

If, on the other hand, applied computer science begins to uncritically appropriate the methods of social sciences, it misses the specificity and potentialities of its own practice. Exhausting its energies while mimicking the procedures of social research and cultural studies, it must necessarily neglect activities of digital artefact creation. Stripped of its constructive capacities, however, it remains useless: Impotent to construct artefacts and inept in the formulation of theory.

In its constructive form, it is a practice interested in *creation of formal and digital artefacts*. Theories employed and methodologies adopted have to do justice to the element of artefact centricity. Accordingly, an adequate methodology has to facilitate joint interdisciplinary processes of making while allowing for the specifics of computing practice to be intelligibly conveyed to others.

Meeting the Methodological Challenge

Within this thesis a tentative methodology to this end is developed, called DivE. Combining elements of practice-based research with material-semiotic assemblage theory, it serves to sustain artefact centric interdisciplinary cooperations in the face of antagonistic epistemological commitments. The steps leading to development and application of the DivE methodology are subsequently outlined.

Cultural processes are exceptionally hard to conceptualise in a way accessible to both the vocabularies of computer science, social research and design. In order to establish a conceptual base as common point of reference, I draw on the concept of *complexity*. Wakkary's notion of *everyday complexity*[2] is complemented through a critical reading of science-and-technology scholar Bruno Latour's conceptual pair of *complexity and complication*.[3] The developed conceptual vocabulary allows not only adequate description of cultural phenomena but also a productive conceptualisation of the relationship between culture and computing.

[2] Ron Wakkary: Framing complexity, design and experience (2005).

[3] Bruno Latour: On Interobjectivity (1996).

In order to find an adequate mode of appropriating cultural theory and its respective methods, I draw on work concerning the Practice paradigm within human-computer interaction.[4] Practice theory, a specific form of cultural theory, is adopted in order to facilitate interdisciplinary discourse. Practices as routinised forms of bodily conduct,[5] emerge as the basic unit of analysis in this paradigm. Respective readings of practice theory allow for coordination on the level of methodology while facilitating theory construction within an overarching shared framework.

Practice theory, however, while allowing for appropriate analysis of cultural phenomena, can shift focus away from artefacts as well as the activities concerned with producing them. In order to sustain an artefact-centric perspective necessitated by constructive practices, a very specific, non-typical instance of practice theory is adopted in the form of Actor-Network-Theory.[6] It is based on the notion that the capacity to act is not exclusive to humans. Consequently, both humans and artefacts are theorised as commensurate carriers of social practices.

On the level of methodology, the paradigm of *practice-based research* offers a mode of theory production through artefact creation.[7] Elements of practice-based research are incorporated into a methodological proposal, able to deal with interdisciplinary development for cultural contexts.

[4] Kari Kuutti/Liam J. Bannon: The Turn to Practice in HCI (2014).

[5] Andreas Reckwitz: Toward a Theory of Social Practices: A Development in Culturalist Theorizing (2002).

[6] Bruno Latour: Reassembling the Social- an Introduction to Actor-Network-Theory (2005).

[7] Maarit Mäkelä: Knowing Through Making (2007).

DivE Methodology

The proposed methodology is based on the idea of acknowledging the insurmountable nature of disciplinary and epistemological differences. Instead of trying to alleviate these differences or smoothing out conflicts, multiplicity in perspectives and diversity on the level of method is treated as an asset. Conflicts that invariably arise, are escalated rather than pacified, clarifying otherwise hidden assumptions, motivations, and convictions.

In order not to be impeded by the diverging dynamics of conflict, the discussion process is embedded into an iterative

practice-based mode of joint artefact creation. Within each iteration, participants jointly produce an artefact. To this end, conflict is suspended momentarily until it resumes once the artefact is constructed and the next iteration begins. Thus, instead of trying to reach agreement on the level of theory and interpretation, participants coordinate on the level of poietic practice. Consequently, the process unfolds as interleaving and overlapping of conflictual negotiations and cooperative acts of making.

This mode of operation is facilitated through adoption of practice-based methods with their primacy of artefact creation. The intended methodological effect is twofold in nature:

- Dissensus on the level of verbal discourse need not preclude a productive outcome on the level of artefacts.
- Conflicts on the level of interpretation are possible without jeopardising the productivity of the joint making process.

Processes of discussion, coordination and interpretation are aided by producing different readings of a shared theory. These readings do not alleviate conflict but situate it. Possessing different readings of a single theory provides a shared vocabulary, thereby clarifying different modes of interpretation and substantiating future discussion. In tandem with the focus on artefacts, these readings act as an intellectual reaction chamber, containing and directing conflictual negotiations in the form of an ongoing communicative chain reaction.

Concrete Practice-Based Studies

Based on the methodology developed, three studies are conducted:

The first one, PRMD, (chapter 5), deals mainly with the sketched problematic of sensitivity towards cultural practices. Based on empirical results, an interactive installation is developed and iteratively situated into in-the-wild exhibition contexts.

The second one, ASSMBLG, (chapter 6), building on experiences of the first, consolidates results, proving the methodology

in a broader context. During its course, the status of code and digital materiality becomes part of the team's concerns and interests.

In the context of the third study, PRTL, (chapter 7), the methodology is ultimately applied reflectively in order to negotiate and communicate the process of code production in the form of a practice.

Prototypes developed are situated within an overarching prototype ecology, developed in the course of an empirical prestudy. An ongoing concern is the question of how to instigate curiosity of users, curiosity towards each other as well as curiosity towards presented subject matter.

Subsequently, experiences made are reflected and further methodological implications are discussed (see chapter 9). The specific nature of knowledge generated through application of DivE is analysed as a form of *situated knowledge*. Key concepts refined during the practice-based research process are those of digital materiality, performativity, and non-use. The necessity to acknowledge phenomena of non-use is treated through adoption of the Latourian notion of *antiprogramming*.

Existing Work

Due to the interdisciplinary character of the work undertaken, situating this thesis in relationship to existing approaches is not uncomplicated. It seeks to connect with positions spanning the domains of social theory, philosophy, and digital art, while still being written by a computer scientist. Identifying a single overarching paradigm thus runs the danger of becoming an exceedingly reductive operation, belying the multiplicity and mutual irreducibility of individual theories and methods.

However, even if a certain approach does not easily lend itself to subsumption under one paradigm, even if inspirations are diverse and multifarious while relationships among paradigms seem more important than any one position in isolation, providing a clear account of individual starting points remains viable. In fact, it is essential in order to detail how

practices of relating themselves are organised; how they are motivated and methodologically sustained.

In this light, perhaps the deepest running inspiration stems from Christiane Floyd's work, specifically her construal of software design as dialogical process. Floyd's call to "endeavour to be receptive to the perspectives of others", to "take up all the other perspectives and allow them to interact"[8] underlies the totality of intellectual work I hope to conduct through this text. Following this basic dialogical interest, individual perspectives are braided together, in order to arrive at a structure able to sustain processes of interdisciplinary prototyping.

[8] Christiane Floyd: Software Development as Reality Construction (1992).

Identifying main strands within this network always carries the risk of inadvertently sidelining important perspectives, of marginalising voices whose strength lies in their unobtrusiveness. Often, it might be these more quiet voices within the discussion who effect the most interesting influence by lending nuance and depth to the text without continuously asserting their own importance.

However, in order to construct a theory, tell a story, or communicate a methodology, one always has to engage in choices, accentuations, and omissions. The vast complexity of the subject matter has to be compressed; certain perspectives are emphasized others are discounted. In order to provide a first conceptual interface into the complex intellectual territory this thesis tries to navigate, I will try and briefly identify some of the main paradigmatic contributions which informed my thinking. In this sense, the main strands can be identified as *critical technical practice*, the Scandinavian tradition of *participatory design* with its emphasis on issues of democracy, in tandem with approaches from the variegated field of *human-computer interaction* (HCI).

Three Waves of HCI

In order to situate this work with respect to discussions within HCI, it might be instructive to relate it to Susanne Bødker's classification of successive "waves" of HCI.[9] Bødker develops a

[9] Susanne Bødker: When Second Wave HCI Meets Third Wave Challenges (2006).

schema, reconstructing the history of HCI in three waves:

The *first wave* coincides with HCI's establishment as a field and the corresponding paradigm of "human factors". Research typically conceived of humans as elements within set organizational processes, such as operators within call-centres, pilots flying airplanes, and engineers utilising CAD software. Respective approaches employed a blend of theories from the fields of cognitive science, management science, and cybernetics. Environments were modelled as socio-technical systems, in which humans contribute to clearly measurable goals. Research activities focused on modelling and formalization in an effort to understand human factors, increase task performance and optimize the efficiency of the overall socio-technical system.

The *second wave* marked a departure or extension of the cognitive paradigm while retaining the focus on well-defined settings, usually within professional environments. Humans were conceptualised not as "factors" within pre-existing procedures but as actors able to set goals for themselves or participate in negotiations concerning the organizational environment in which they work. Drawing on theories such as distributed cognition and activity theory, research efforts in HCI tried to paint a more variegated picture of interactive technologies. Second wave approaches focused on the context in which digital artefacts were to be used. Crucially, second wave approaches sought not only to further given institutional agendas but to create the conditions for humans to negotiate how they want to relate to digital artefacts. The influential approach of *participatory design* aimed to democratise practices of interaction design, through application of humanist thought to pragmatic design cases in the sphere of work. Second wave research brought HCI into dialogue with a further set of disciplines by incorporating elements from anthropology, sociology, and the humanities.

Third wave approaches criticised the second wave's focus on supporting pre-existing systems of practices, especially the focus on work. Proliferation on the level of digital technologies

had expanded the reach of interactive technology well beyond the professional realm, in turn necessitating an amendment of received research methodologies. Subsequent rapid success of mobile technologies radically challenged received notions of place and context, in turn upending corresponding research methodologies. Artefacts such as smartphones enabled a wide array of practices which do not contribute to a clearly delineable institutional agenda. Activities such as updating social media profiles, microblogging, commenting on live events through real-time chats, documenting everyday life in the form of short videos, playing augmented reality games, or keeping in touch with others through messaging apps cannot easily be accounted for in the form of tasks, goals, and efficiency. They are ill-described in terms of effectiveness and users typically do not define goals but derive an experiential, communicative or hedonist surplus through respective practices of use. Accordingly, third wave research focuses more on questions of experience and meaning-making. Theoretical paradigms such as phenomenology, already present within second wave approaches, thus acquire new importance in the third wave.

Situating this thesis among the waves

While I mobilize the classification of HCI's three waves in order to situate this thesis, I do view it as fundamentally problematic. Within the HCI community, it appears to be employed in order to describe a progression from narrow-minded technology-focused discourse to a more open-minded discourse, able to do justice to the complexity of human lived experience. However, this kind of linear narrative might be overly reductive. Indeed, one could argue how the third wave simultaneously becomes more technology-centric by moving away from the idea of humans collectively setting goals for themselves. Instead, the focus lies on novel experiences facilitated by technological artefacts, often in the form of platforms and gadgets.

The present work incorporates facets of both recent waves through its implicit focus on "autonomy" as mentioned above.

Furthermore, questions of collective negotiation of these goals are paramount with respect to the interdisciplinary design process. At the same time, it retains a third wave focus on experience.

Critical Technical Practice

Critical technical practice (CTP) as articulated by Phil Agre[10] provides a helpful paradigmatic bracket for the totality of poietic practice undertaken.

[10] Philip Agre: Toward a critical technical practice (1997).

CTP developed out of Agre's endeavour to "reform" the field of artificial intelligence in the 1980s. Agre perceived contemporary paradigms of framing AI systems to be deeply limiting, yet was frustrated by his inability to articulate a cogent immanent criticism of AI design practice. Agre was convinced that existing practices of AI were missing crucial aspects of human life. However, every form of criticism seemed to lead to the same trodden forms of argument. The necessity to render criticism commensurable to existing forms of AI discourse appeared to negate its critical edge: translating the complexity of everyday life to existing AI formalisms inevitably transformed the problematic into the language of goal-oriented planning. At the same time, insisting on the incommensurability of human experience to formal structure as phenomenological theory suggests, seemed to diminish the argumentative force of the constructed philosophical position: If it did not translate into software, how could its relevance for the field of AI be established?

With the help of David Chapman, Agre arrived at an "embodied" critique in the form of an AI system: a practice-oriented implementation of an AI agent, able to play the arcade video game Pengo.[11] The system works through markers, whose meaning is established in relation to a practice the agent within the game is carrying out. Markers were embodied in the sense that their meaning is established relative to an agent's practice and bodily situation ("the-block-I-am-hiding-under", "the-enemy-I-am-chasing", etc.).

[11] Philip Agre/David Chapman: Pengi (1987).

Crucially, this instance of CTP based itself on construction of a digital artefact. It presented its arguments not only in linguistic form but also as digital system. At the same time, it criticised the "short circuit logic" of existing AI practice, which precludes the possibility of a differing paradigm.

Framed within sociological terms, Agre's basic problematic could be reconstructed as trying to articulate an antipositivist position (Heideggerian phenomenology) within the positivist framework of AI discourse. The underlying problematic might be compared to what Theodor W. Adorno framed as the "compulsory character of logic":[12] the inability to bring to life concrete entities within a system of general concepts which precludes the possibility of any object to exceed the formal terms of its description.

[12] Theodor Adorno: Minima moralia (2005), Aphorism 98.

Interestingly, Agre was indeed able to transcend the limits of AI discourse, without leaving the frameworks of science or having to resort to an "outsider" position. Crucially, in contradistinction to Heidegger or Adorno, Agre develops this critique in the form of a technical apparatus. At the same time, Agre runs the danger of circumscribing Heideggerian theory into a sociological framework focused on practices, bypassing the more fundamental ontological distinction Heidegger seeks to establish.[13]

[13] Jethro Masís: Making AI Philosophical Again (2014).

While Adorno claims that "Immanent critique has its limitation in the fetishized principle of immanent logic", Agre develops a material practice of argumentation which combines criticism obtained from without (existential phenomenology) with concrete practices of making from within (creation of a serviceable and observable AI system).

Paradigmatically, CTP anticipated developments that much later would become practice-based research. What it does illustrate is the necessity to translate intellectual convictions and theoretical discussion into concrete digital artefacts, in the form of software or interactive prototype. It thus points simultaneously to the potentials and limitations of philosophical discourse with respect to practices of digital making. In this sense, CTP

served as a guiding principle regarding the methodological building blocks I developed, as far as they relate to concrete poietic practice.

Participatory Design

Among so-called second wave approaches, participatory design (PD) occupies a special position in relationship to this thesis. This is mainly due to contributions made by Swedish researcher Pelle Ehn during the formative years of this respective research paradigm. By drawing on Wittgenstein, Heidegger, and Kosík, Ehn combined humanist thought into a pioneering project of democratic design[14] of digital artefacts.

PD bases itself on the premise that digital artefacts should be the product of a democratic dialogue of stakeholders, rather than the output of professional discourse between customers and contractors. To this end, Ehn conceived of a design process which is organised as equitable negotiation among socially and professionally diverse participants. Tangible design prototypes are employed in order to facilitate discussions among stakeholders. The process itself tries to engender and remain receptive to the specificity of experiences made by its participants.

Crucially, Ehn provides a discussion of the antagonistic dynamics inhering within organizational culture. These are not discussed in order to devise methods to most efficiently resolve or navigate them. Rather, they are conceptualised as indissolubly linked to the play of social forces which condition any process of artefact design.[15]

Ehn's texts themselves mark a compromise between his political interests and the specific demands and standards of the academic system. The genesis of "Work Oriented Design of Computer Artifacts" illustrates this fact. Though lauded as seminal approach within the field of human-computer interaction by later generations of computer scientists and interaction designers, the text only partly reflects its author's thinking at the time.

[14] Pelle Ehn: Work-Oriented Design of Computer Artifacts (1988).

[15] Pelle Ehn/Åke Sandberg: God Utredning [Good Investigation] (1979).

Ehn previously authored “Företagsstyrning och Löntagarmakt” (Management Control and Labour Power)[16] together with Åke Sandberg, which focused on work done with local trade unions. This text, however, could not garner approval within the academic community, prompting Ehn to author “Work Oriented Design of Computer Artifacts” in order to gain professional recognition.[17]

[16] Pelle Ehn/Åke Sandberg: Företagsstyrning och löntagarmakt (1979).

[17] Pelle Ehn: Learning in Participatory Design as I Found It (1970–2015) (2017).

In fact, this antagonistic moment adds a helpful level of complexity: PD points to a practice “out there” which can be reflected upon academically, rather than being a product of the academic system itself.

Furthermore, Ehn details a valuable historical connection when he describes digital interfaces as postmodern phenomena: Born from a fusion of arbitrary signs and idiosyncratic language games, both interface and postmodern building seek to hide their inner workings and complexity behind a veneer of pleasurable decorations and visual similes. In so doing, the link between the interface-as-facade and the underlying digital logic remains as arbitrary as that between postmodern building and its facade. Additionally, interfaces at that time just like postmodern buildings often tried to masquerade their novelty by evoking familiar forms and relationships: The desktop metaphor was introduced to mask the alien workings of computers by drawing on familiar associations between users and their work environments. Analogously, individual signs such as the recycle bin or folder evoke familiar objects, whose real-life meaning nonetheless differs from that of their digital counterparts. Thus, visual signs within the graphical interface illustrate and obscure the logic of the computer at the same time.

What is of interest here is not so much the specific connection between digital artefacts and historical formation. Rather it is the way Ehn’s text engages the phenomenon of postmodernism and attempts to relate it with practices of digital artefact creation. In so doing, Ehn’s text provides a model for negotiating the relationship between a digital artefact and its cultural context.

Digital Art

Lastly, the discourse surrounding the problematic of digital art can serve as a point of reference for it illustrates the relationship between digital artefacts and cultural phenomena. It reminds us how software and interactive systems themselves can be read as cultural artefacts and thus inoculates against the fallacy that there is a cultural environment “out there” to which digital artefacts can merely relate: As soon as we place interactive artefacts within a cultural space, we perturbe this space, since digital artefacts themselves possess cultural valence. This, consequently, allowed to alert participants towards the specific sensitivity of cultural spaces with respect to digital artefacts.

Bootstrapping the Reading Experience

Due to the intertwinement of practice-based engagement, theoretical, and methodological work, there are many possible ways to approach and read this text. In the following, I will outline one possible intellectual trajectory in order to guide readers through the document.

The question of how to structure an interdisciplinary process tasked with developing interactive artefacts for museum environments can serve as a productive intellectual point of departure. In order to get acquainted with the problem, the reader might start at section 4.1, which contains an analysis of the practice of an exhibition visit. Concrete examples discussed there briefly illustrate both the necessity for and challenges inhering within interdisciplinary work.

Based on this preliminary exposure to concrete problems, the reader could backtrack, asking herself “What methodologies are already in place to solve problems encountered?”. Chapter 3 provides some answers to this question in the form of a discussion of existing methodological approaches.

In order to gain a deeper and terminologically more precise understanding of concepts used throughout the text, the reader is then invited to turn her attention to chapter 2. The chapter discusses concepts and theories used throughout the text.

A subsequent reading of chapter 8 will most likely constitute one of the principal focuses of any reader’s intellectual engagement with the text. It introduces the DivE methodology for interdisciplinary prototyping, which was developed in reaction to experiences made during practice-based projects. The reader is invited to read this chapter against the three practice-based projects detailed in chapters 5 – 7.

Finally, results of practice-based engagements are summarised in chapter 9, before chapter 10 provides a conclusion. Understanding the structure of knowledge created during an interdisciplinary DivE process (section 9.3) will prove especially valuable for any reader trying to reconstruct the methodology's mode of operation. A succinct summary of thesis outcomes is provided in section 9.4 in the form of main claims and hypotheses.

Thesis Outline

Chapter 2 lays the theoretical and terminological groundwork for this thesis by introducing the distinction between complexity and complication. Crucially, the notion of complexity allows for a productive theorisation of (digital) artefacts as *material frames*: Material frames act as complicating agents, imposing a common repeatable form on social practices. The chapter proceeds by introducing the *Practice Paradigm* within Human-Computer Interaction which informs individual subsequent readings of practice theory. Furthermore, the text discusses the notion of *boundary objects* which allow for a conceptualisation of how a single theoretical artefact can be appropriated by dissimilar disciplinary communities.

Chapter 3 discusses existing methodological building blocks which the DivE methodology later draws on. Central to the discussion is practice-based research, specifically the notion of “Knowing through Making”. The notion of *hybrid projects* provides a contextualisation of practice-based research adequate to interdisciplinary prototyping in contexts of technology research.

Chapter 8 describes the DivE methodology for interdisciplinary prototyping. DivE is introduced as an iterative methodology before the chapter proceeds by detailing the methodology’s overall structure as well as its constitutive activities and procedural elements.

Subsequently, the thesis provides discussion of concrete making projects. These form the experiential basis of DivE’s progressive development while having been informed by preliminary versions of it. Individual projects are part of a sustained effort to combine methodological and technological elements within a practice-based process of understanding the relationship of digital artefacts and cultural spaces.

Chapter 4 describes both the technological infrastructure developed in order to materialise conducted projects and a prototype ecology developed to support concrete practice-based processes. Specifically, the chapter discusses the LOOPHOLE rapid prototyping system, aimed at facilitating joint interdisciplinary development of digital artefacts. I developed this layered architecture in order to give individual project participants equal access to digital artefacts irrespective of their individual skill sets or level of technological literacy.

Chapters 5 – 7 discuss the concrete practice-based projects undertaken as part of this thesis: The first of these projects, PRMD (chapter 5), is an interactive installation realised via full-body tracking. It allows users to experience biographical narratives in pairs of two. A special event in the narration triggers a surprise element intended to engage users and foster communication. Concepts negotiated during the PRMD project included the relationships between identity, historical knowledge, and performativity.

The second project, ASSMBLG (chapter 6), concerned itself with development of a tangible user interface for deployment in museums. The project led to an exploration of the concept of digital materiality.

The third project, PRTL (chapter 7), comprises development of algorithmic collage generators. By making code elements interactive it revisits the problematic of digital materiality. It followed an inquiry into the relationship of algorithmic infrastructures and power relations.

Chapter 9 discusses observations and results generated. The discussion of individual project outcomes is grounded in an analysis of the kind of knowledge generated during DivE processes. An interesting methodological addition to the DivE framework is the notion of *anti-programming*. It stems from the realisation that in order to further cultural experiences it is also necessary

to engineer users' practices of non-use of artefacts, to decouple them from digital artefacts. Developing strategies to achieve this disengagement from technology is as important as constructing engaging artefacts themselves. A summary of central claims and theses (section 9.4) concludes discussion of results.

Chapter 10 provides the conclusion of this thesis.

2
Theoretical Framing – Complexity + Complication

IF PEOPLE DO NOT BELIEVE THAT MATHEMATICS IS SIMPLE, IT IS ONLY BECAUSE THEY DO NOT REALIZE HOW COMPLICATED LIFE IS.

– JOHN VON NEUMANN

The present chapter seeks to establish an adequate theoretical framing for development of a practice-based research methodology aiming at development of interactive artefacts in cultural spaces.

Choice of a conceptual underpinning for an interdisciplinary methodology is not a simple problem. Researchers and practitioners converse in different epistemological communities, employ different construals of constructed artefacts, develop different framings for goals and motivations.

In turn, differing perspectives are inscribed into artefacts. Computer-code, formal models, ethnographies, situational maps bear the marks of heterogeneous epistemological commitments. Yet, all of these must play together in order for development of a cultural digital artefact to succeed.

The proposed approach calls for turning said artefacts into boundary objects[1] by employing a theoretical framing based on the notions of *complexity* and *complication*.

[1] The notion of boundary objects is further discussed in section 2.4.

2.1 Approaching Complexity

Motivated by development efforts within museum contexts, Wakkary introduces a complexity-based construal of design processes.[2] Drawing on Winograd,[3] he situates his own practice within interaction design, which is "understood to be an inter-disciplinary convergence of design and HCI (human-computer-interaction), inclusive of aspects of interactive art, performance, computing science, cognitive science, psychology and sociology".[4]

[2] Ron Wakkary: Framing complexity, design and experience (2005).
[3] Terry Winograd: The Design of Interaction (1997).

[4] Ron Wakkary: Framing complexity, design and experience (2005), p. 65.

Wakkary proposes complexity as conceptual frame for informing practice based design endeavours. Within the text, complexity is used as an intellectual device serving two goals: It is used to describe the unique rich interactional networks present within everyday situations and design activities as well as for contrasting the adequate situated mode of action of designers with that of uninterested, 'objective' observation. Opposing 'representational'[5] and 'interactional' approaches, Wakkary formulates complexity as a concept suitable for the latter.

[5] Herbert Alexander Simon/Laurent Siklossy: Representation and meaning (1972); Paul Dourish: What We Talk About When We Talk About Context (2003); Paul Dourish: Reconsidering Software Representations (1997).

Complexity in this sense points towards the analytic irreducibility and non-representability of design problems. Complex situations are those that defy analysis through disinterested observation; complex problems are those that can be approached only through practice. When dealing with situations of this kind, we always already find ourselves entangled in a web of interaction and negotiation precluding efforts of advance planning.

In response to those intractabilities, Wakkary proposes an approach similar to *dead reckoning* in navigation.[6] Thereby, he sketches an incremental design methodology dealing with the exigencies of complexity. It consists of setting a general direction for the design process, which is modified and corrected during every design decision. At every point within the design process, a course correction is performed, whose direction is marked in reference to the last. This entails a gradual, practice-based discovery both of users' life-worlds as well as designers' perspectives.

[6] Ron Wakkary: Framing complexity, design and experience (2005), pp. 7, 10.

Designers are seen as acting within and responding to complex situations. Design in turn, is viewed as a complex activity in itself. However, neither is design limited to complex methods, nor does it necessarily produce complex outcomes. Its methods range from the simple to the complex. In response to complexity encountered, design is able to generate *simple* outcomes in the form of artefacts.[7] Thus, in this specific case, design performs functions such as complexity modulation and complexity reduction. This line of thought is congruent with the positions of authors such as Humberto Maturana, Francisco Varela, and Niklas Luhmann, who provide a systems theoretic account of concepts such as complexity reduction.[8,9]

Complexity thus is proposed as an alternative intellectual approach to a problematic otherwise approached through concepts such as context[10] or through custom made models lacking an overarching intellectual horizon.[11]

These observations are coupled with clear methodological and practical implications. Wakkary is clear in highlighting the necessity of adopting an active stance in the face of complexity, conflicting with the ideal of uninterested, 'objective' observation and theorising.[12]

[7] Ibid., p. 67.

[8] Humberto R. Maturana/Francisco J. Varela: The tree of knowledge (1987).

[9] Niklas Luhmann: Soziologie Als Theorie Sozialer Systeme (1970), p. 116.

[10] Bonnie A. Nardi: Context and consciousness (1996); Paul Dourish: What We Talk About When We Talk About Context (2003).

[11] Jonas Löwgren/Erik Stolterman: Methods & tools (1999).

[12] Ron Wakkary: Framing complexity, design and experience (2005), pp. 67–68.

2.1.1 Existing Positions: Critical Appraisal and Limitations

Wakkary provides a detailed account of practice-based investigations of the complex which is tested in the context of cultural spaces. It thus serves as a valuable reference point for development of a methodology suited for development for cultural spaces.

However, some limitations remain.

The account given of computing practice is too narrow: Computing practice emerges as the limited 'Other' of a design practice designated as *non-rational*. To the author of this text, there is no alternative to rational methods. This does not need to denote a substantial departure from Wakkary's approach, for the notion of non-rational phenomena is not spelled out in Wakkary's text. However, it points towards the need to

clearly develop a conceptual alternative. How can the difference between formal, representational methods and complex, situationally rich phenomena be described?

Furthermore, the strong focus on situated and interactional aspects, understood as concerning the actions and experiences of humans, might not adequately reflect the high level of artefact-centricity I feel to be inherent within constructive computing practice. This is a characteristic Wakkary's approach arguably shares with many approaches in the realm of HCI, such as the widely influential paradigm of *embodied interaction*[13] (EI) (see section 5.3.1).

[13] Paul Dourish: Where the Action Is: The Foundations of Embodied Interaction (2004).

As could also be argued for EI, the sustained highlighting of interactional and situational qualities during Wakkary's discussions can detract from the high level of artefact-centricity I feel to be inherent within constructive computing practice. The challenge thus becomes that of developing an artefact-centric approach without lapsing into the oversimplifying representationalism Wakkary so aptly criticises.

The question of how to describe the non-non-rational positively while adopting an artefact-centric perspective will prompt me to examine the writings of another author: Bruno Latour and his contradistinction of *complexity* and *complication* against the background of *Actor-Network-Theory*.

2.2 Latourian Theory: ANT + Complexity

2.2.1 Approaching Latour

The utility of social research theories and methods for constructive methodology is not immediately obvious. Social research methods typically aim at generation of a system of propositions describing observed practice, not at advancing the practice in question. Even if their methodologies call for participation within the practices analysed, as is the case with techniques such as participant observation, produced theoretical artefacts typically do not aim at contributing to the success of respective practices: Analysis of computational practice in a field such

as science and technology studies produces theory aimed at reconstructing and understanding modes of digital technology construction. It does not explicitly try to change it. Typically, respective disciplinary languages and theories are geared towards the discourse within their specific area, social research, while leaving open the question how other disciplines might relate to them.

At first glance, Latour's theories are no exception, they reconstruct phenomena from the perspectives of the ethnographer, social theorist, philosopher. However, they are rendered special through the conditions of their reception. Theory elements such as material-semiotic assemblage theory already have been adopted within the contexts of HCI and CSCW (Computer Supported Cooperative Work),[14,15] thus forming a conceptual bridge between disciplinary discourses. Actor-Network-Theory, specifically, was discussed across a wide range of disciplines, allowing me to draw on translations across disciplinary boundaries that otherwise would have to be laboriously constructed.

Central to the purposes of this thesis is Latour's construction of the conceptual difference between complexity and complication which I will retrace in the following paragraphs:

[14] Yvonne Rogers: HCI Theory (2012), pp. 54–55.

[15] Verena Fuchsberger: Generational divides in terms of actor-network theory (2011); Verena Fuchsberger/Martin Murer/Manfred Tscheligi: Materials, Materiality, and Media (2013); Verena Fuchsberger/Martin Murer/Manfred Tscheligi: Human-computer Non-interaction (2014).

Complexity + Complication

The differentiation of complexity and complication appears at multiple sites within Latour's writing, acting in different capacities. Situating the conceptual pair in relationship to constructive methodology thus calls for a careful reading of relevant source texts.

The difference between complexity and complication is developed in *On Interobjectivity*[16] as well as the cross-media publication *Paris: Invisible City* co-authored by Emilie Hermant.[17] A precursory usage of the term can be found within the text *Redefining the social link* authored by anthropologist Shirley Strum and by Latour.[18]

[16] Bruno Latour: On Interobjectivity (1996).

[17] Bruno Latour/Emilie Hermant: Paris: Invisible City (1998).

[18] Shirley S. Strum/Bruno Latour: Redefining the social link (1987).

Like Wakkary, Latour introduces complexity as a specific need for coordination: A complex situation forces us to take into account a large number of variables simultaneously.[19]

> "Complex" will signify the simultaneous presence in all interactions of a great number of variables, which cannot be treated discretely.[20]

[19] Bruno Latour: On Interobjectivity (1996), p. 233.

[20] Ibid., p. 233.

Complexity is hence seen as characteristic of forms of social integration based on continuous interaction and negotiation. The intricate interplay of auditive filtering, playing, listening, readjusting exhibited by instrumentalists within an orchestra performance constitutes a complex whole. An animated conversation at a bar or the actions of football players, based on continuous observations and situational reevaluations, constitute complex phenomena as well.[21] As such, complexity is not limited to human societies – complexity already occurs within primate societies, forcing their members to ceaselessly engage in strategic interaction in order to maintain social order.

[21] Bruno Latour/Emilie Hermant: Paris: Invisible City (1998), p. 30.

Complication on the other hand, refers to a process decomposable into a limited set of discrete variables, which, in principle, can be treated successively.

> By contrast, we'll call "complicated" all those relation[s] which, at any given point, consider only a very small number of variables that can be listed and counted.[22]

[22] Ibid., p. 30.

It is not important if the relevant operations are indeed performed sequentially or in parallel, but that they can be performed in sequence, not interfering with one another. Examples of complicated situations can be found in bureaucratic processes, such as scheduling, or in scripted repetitive interactions, such as buying stamps from a postal clerk.[23,24]

[23] Ibid., pp. 30–31.

[24] Bruno Latour: On Interobjectivity (1996), pp. 233–234.

Crucially, *complication* allows for processes to be repeated and facilitated by what Latour calls *material frames*. Material frames are artefacts that limit the scope of interactions, rendering them redundant and repeatable. Complexity is hidden in a process of *blackboxing*. A postage clerk's workplace is designed in a way that allows for successive interactions to follow a common script. It cuts off other interlopers, organising their actions into a sequential and discrete process. Interactions that

can be subdivided and organised into a discrete succession of events thus are amenable for support through a material frame. The post office's spatial layout organises customers into a line, creating a sequential stream of comparable interactions.

Interactions themselves are insulated from one another; they are distributed into discrete variables, precluding interference. This capability for organising interactions is what gives artefacts the ability to act as "storage" of social protocols, to embody interests and motivations.[25] Artefacts thus allow for the *complication of complexity*. They provide the means, "which permit passage from a situation that is complex to one that is merely complicated".[26]

[25] Bruno Latour: Technology Is Society Made Durable (1990).

[26] Bruno Latour: On Interobjectivity (1996), p. 233.

Latour identifies a trend towards complication with the development of technologically advanced societies. While primate societies have to achieve organisation exclusively through complexity, human society has introduced elements of complication. Serialisation, redundancy and repeatability inhering within complicated phenomena allow for forms of organisation not possible otherwise.

In summary, we have encountered three qualifiers of analysed phenomena: complex, complicated, and simple. These are all mutually different; complex and complicated both entail non-simplicity,[27] while being further differentiated against one another.

[27] Ibid., p. 233.

It has to be stressed that the distinction between complexity and complication is not a binary one. In effect, complexity and complication form a differential continuum, stretching from highly interactionally interwoven phenomena, whose variables resist definition, to those amenable to formal description and algorithmic treatment. When developing their position, Latour & Hermant explicitly situate computing machinery at the pole of complication. The pole of complexity, in contrast, is occupied by 'the art of conversation'.

> The art of conversation could be seen as an extreme; the opposite extreme would be the computer, a complicated folding of relations that the indefinite redundancy of the machine allows us to process as series of zeros and ones.[28]

[28] Bruno Latour/Emilie Hermant: Paris: Invisible City (1998), pp. 30–31.

In order to understand the complexity pole of the continuum, revisiting Latour & Hermant's definition is instructive. While in the above citation, Latour talks about "a great number of variables, which cannot be treated discretely",[29] the authors choose a stronger formulation in their subsequent publication.

> Complex relations force us to take into account simultaneously a large number of variables without being able to calculate their numbers exactly nor to record that count, nor, *a fortiori*, to define its variables.[30]

It is stronger since it precludes definition of relevant variables, in addition to requiring that they cannot be treated as discrete entities. The reading offered in this text, situates both definitions within the complexity-complication continuum. Inability to define variables is seen as a stronger form of complexity than that described through non-discrete variables.

[29] Bruno Latour: On Interobjectivity (1996), p. 233.

[30] Bruno Latour/Emilie Hermant: Paris: Invisible City (1998), p. 30.

Figure 2.1: Complexity vs. Complication: Complicated phenomena can tractably be analysed into a small set of variables which, in principle, can be counted and treated sequentially. Complex phenomena exhibit a large set of densely interrelated variables, which cannot be tractably treated sequentially, or cannot even be listed.

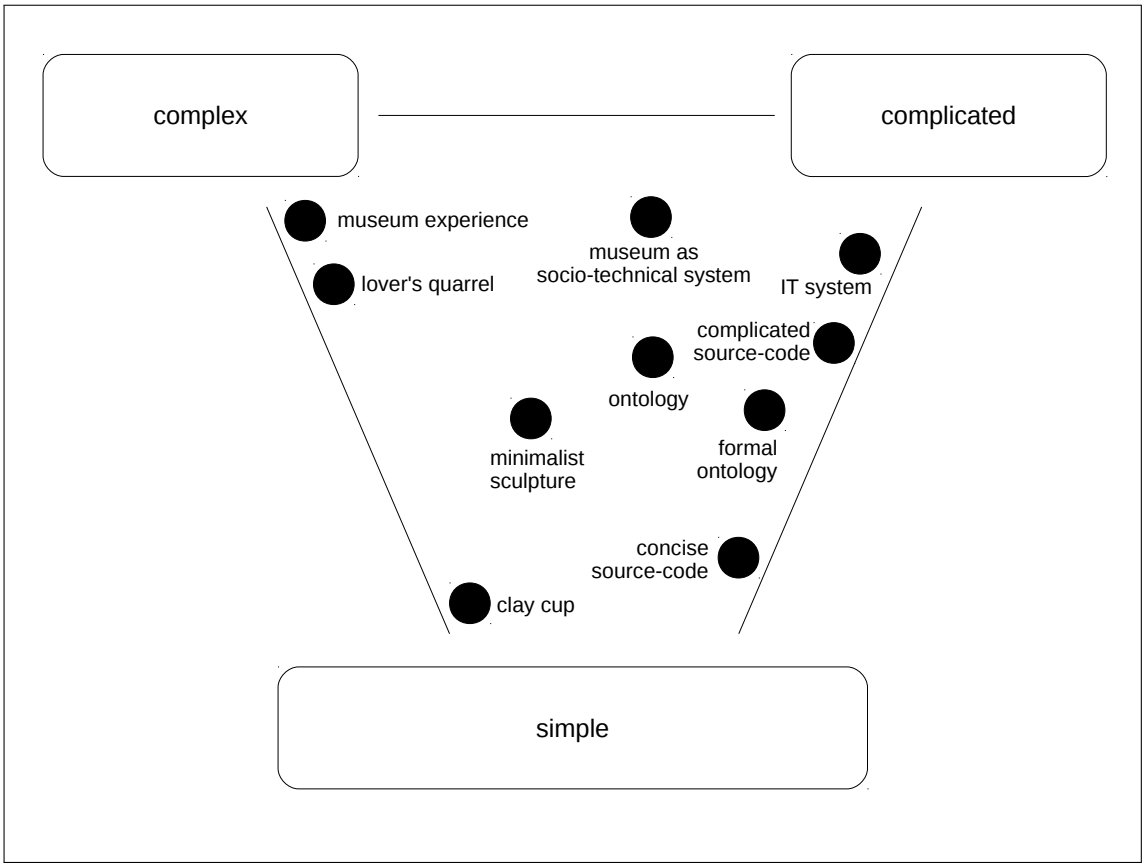


Figure 2.2: Artefacts within the Complexity – Complication Continuum

Since both complexity and complication entail non-simplicity, the resulting schema can be visualised in the form of a triangular diagram (see fig. 2.2). Situating poles of complexity and complication on the upper corners and simplicity at the bottom centre produces a visual reading of the dimensions of complexity and complication, allowing for individual phenomena to be simultaneously graded according to both continua.

At this point, it is imperative to take note of the gross oversimplification entailed by creating a visual apparatus of this kind. While a diagram ordering elements on a scale provides illustration, it remains highly problematic. When real-life phenomena are concerned, they always contain elements of differing complexity and complication. The structure of these inner relationships determine their status as much as does a simple grading based on complicatedness and simplicity.

2.2.2 Specificity of Latour's Approach

Latour offers conceptual tools for differentiating computing practices through use of the complexity / complication distinction. The theory sustains artefact-centric perspectives compatible with constructive practices in the domain of computing. This is done in the form of a boundary object: constructive practitioners can appropriate the theory in a way compatible with their practice while social researchers read it according to theirs.

The role of artefacts and source code becomes accessible through the notion of the *material frame*. Furthermore, the dynamic of blackboxing / clearboxing[31] allows for a description of the role of artefacts during contexts of construction and use. Blackboxing and clearboxing are useful for describing both the hidden nature as well as the communicative qualities of code.

[31] Bruno Latour: Pandora's hope (1999), p. 304.

2.3 The Practice Paradigm

Within their text *The Turn to Practice in HCI* Kuutti & Bannon conceptualise the notion of practice against the backdrop of social research literature and HCI methodology. Their reconstruction of practice is embedded in an argument for a novel research paradigm seeking to consolidate existing research activities within HCI through explication of a refocused conceptual base.

Departing from an analysis of existing HCI methodologies, Kuutti & Bannon oppose two perspectives, labelled *Interaction* and *Practice*.

Inquiry within the *Interaction paradigm* focuses on momentary, repeatable activities. It aims to abstract from historical, cultural, and concrete spatio-temporal conditions in a quest for general, contextinvariant truths. Thus, it aims to generate propositions whose validity and structure are independent from individual characteristics, historical condition, studied culture, or other variables unrelated to the set of hypotheses tested. Within the Interaction paradigm, phenomena are approached

through methods operating on controlled environments such as laboratory situations, oriented towards clearly defined repeatable tasks, usually conducted within short-term studies involving a high number of participants. Typical is a focus on the dyadic relationship between human and artefact.[32]

In contrast, the *Practice paradigm* concerns itself with phenomena observed and reconstructed within specific, culturally and historically contingent situations. This novel perspective necessitates abandoning the clear-cut division between phenomenon and context, for these cannot be separated as was the case within the Interaction paradigm. Materiality, situationality and historicity are "interwoven within the practice".[33] Methods adopted are more often qualitative, draw on observational and case studies. Instead of isolating salient features into variables, they try to relate artefacts, routines and people into meaningful wholes for analysis.

Consequently, both paradigms differ in respect to their basic unit of analysis. Interaction-based approaches dissect phenomena into a set of tasks, dependent on a set of formal variables, amenable to repeated testing. Practice-based approaches deconstruct phenomena into situated performances and processes that, resisting further analytic reduction, have to be studied within the concrete conditions of their occurrence.

Described paradigmatic differences entail a different relationship to the problematic of culture. While the Interaction-paradigm tries to factor out cultural specificity, the Practice paradigm necessarily has to reflect on the cultural:

> The Interaction paradigm eschews any need for politics in its analysis, or for cultural specificity, focusing on the modalities of interaction in the here and now, isolated from other activities and from most features of the setting. The Practice paradigm necessarily includes aspects of values and thus the cultural and political, in the origins and development of the practice.[34]

The novel perspective introduced necessitates a readjusted theoretical base, accounting for cultural complexity. With recourse to sociologist Andreas Reckwitz,[35] Kuutti & Bannon identify practice theory as a specific instance within the broader field of *cultural theory*. This specification of practice theory

[32] Kari Kuutti/Liam J. Bannon: The Turn to Practice in HCI (2014), p. 3543.

[33] Ibid., p. 3543.

[34] Ibid., pp. 3544–3545.

[35] Andreas Reckwitz: Toward a Theory of Social Practices: A Development in Culturalist Theorizing (2002).

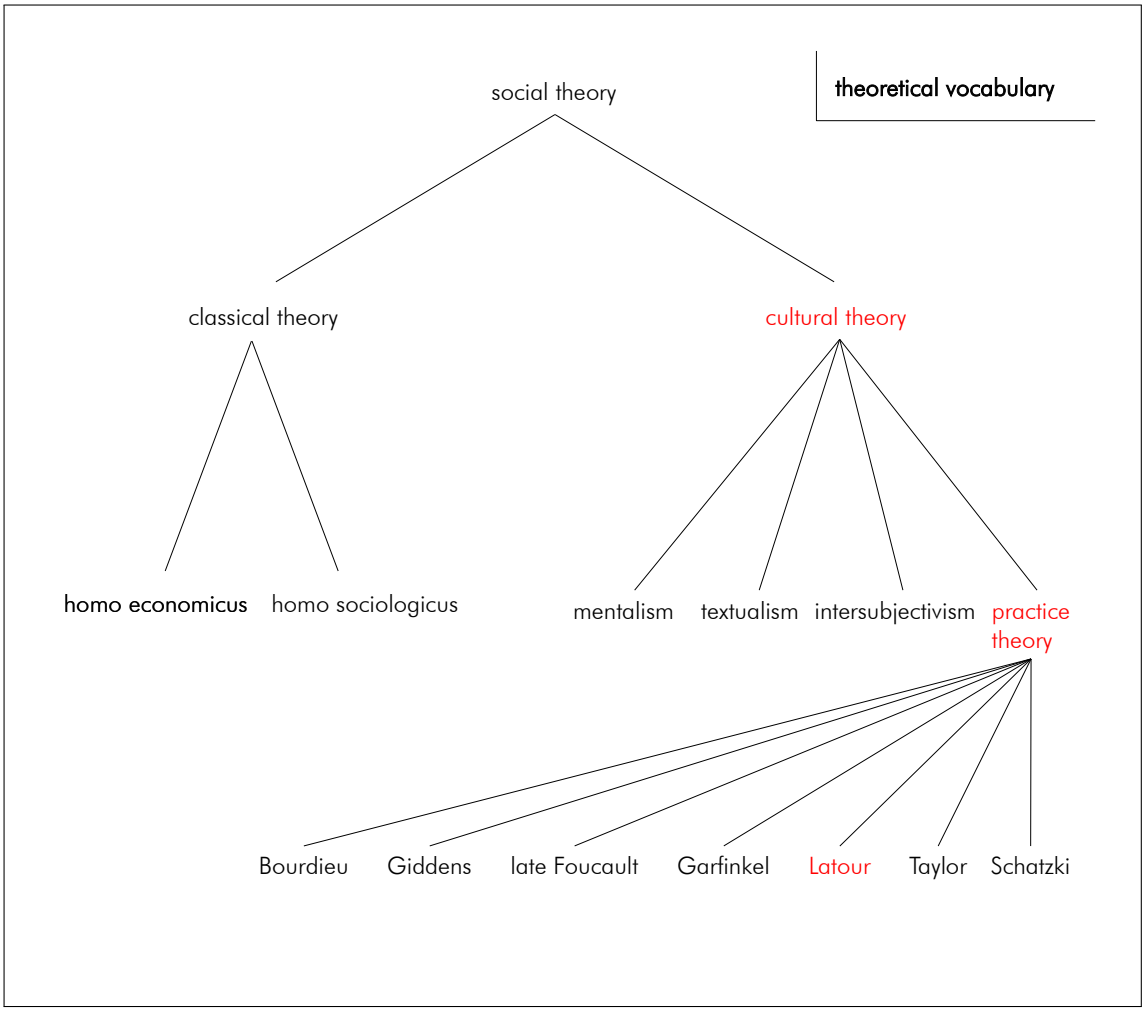


Figure 2.3: Taxonomy of Social Theory based on Reckwitz

bases itself on an extensive taxonomy of social theories proposed by Reckwitz (see fig. 2.3). In his article *Toward a Theory of Social Practices: A Development in Culturalist Theorizing*[36] he first opposes classical and cultural social theory: Classical theories base themselves on the idea either of the self-interested homo economicus or of the norm-oriented homo sociologicus. Society in turn is analysed through the intellectual lens either of rational actions or of societal norms.

[36] Andreas Reckwitz: Toward a Theory of Social Practices: A Development in Culturalist Theorizing (2002).

Cultural theory in contradistinction is based on the concept of "symbolic structures of meaning".[37] Social order is not the result of a normative consensus, nor does it emerge as fixed-point in a series of self-interested decisions. Rather, social phenomena are stabilised and structured by "shared knowledge".[38] Cultural theories differ substantially in how they conceptualise genesis and effect of these stabilising forms of shared knowledge.

[37] Ibid., p. 244.

[38] Ibid., p. 246.

Within the field of cultural theories, Reckwitz differentiates practice theory against mentalism, textualism, and intersubjectivism:[39] *Mentalism* situates the social either within a collective objective unconscious mind, or within individual subjective minds. In the objective case, social order reproduces within a collective unconscious mind reproducing itself through systems of signification. In the subjective case, intentional acts within subjective minds form the basis of study. *Textualism* analyses social phenomena through study of texts, discourses, systems of signifiers. *Intersubjectivism* studies interactional speech-acts, whose pragmatics in turn determine social structures. Each discussed theory provides a specific vocabulary for framing cultural dynamics. They are neither true nor false in themselves, rather serving as frameworks for structuring propositions guided by empirical results.[40]

[39] Ibid., pp. 246–250.

[40] Ibid., p. 257.

As was pointed out, practice theory constitutes a specific genus within the field of cultural theories. It is based on "shared knowledge",[41] that in the form of know-how guarantees the relative stability of behaviour and thought observable with respect to human conduct. It consequently, takes as smallest unit of

[41] Ibid., p. 246.

analysis the notion of *practice*. A practice is a routinised form of activity. As such, it comprises bodily performance, as well as mental activities such as understanding, interpreting and feeling. It usually connects human individuals and things, and is based on a tacit form of know-how. Complicated artefacts can be part of complex practices, stabilising them, as further theorised within the work of Latour.

It has to be stressed that practices, in themselves, are neither complex nor complicated, typically containing elements possessing both qualities. In the form Kuutti & Bannon define them, practices can successfully be situated within the complexity/complication continuum.

> Practices are wholes, whose existence is dependent on the temporal interconnection of all these elements, and cannot be reduced to, or explained by, any one single element.[42]

[42] Kari Kuutti/Liam J. Bannon: The Turn to Practice in HCI (2014), p. 3545.

This irreducibility of practice points to the necessity of inclusion of the concept of complexity into their analysis.

> Practices are relatively stable performances, ways how things get done, continuously produced and reproduced.[43]

[43] Ibid., p. 3545.

This relatively stable nature of practices points towards their connection to *complication* as discussed above (see 2.2.1). As far as they contain redundancy, they are amenable to the stabilising support of material frames. Going a step further, as is necessary in the context of Actor-Network-Theory, artefacts themselves become acting elements, performing practices according to the material conditions inscribed within their bodies.

Analysis of concrete situations has to uncover the exact configuration of the material-semiotic assemblage and the specific compositions of complex interrelationships and complicated elements.

Dimensions of Practice Following organisation studies scholar Davide Nicolini,[44] Kuutti and Bannon further substantiate the concept of practice through identification of five dimensions:

[44] Davide Nicolini: Practice theory, work, and organization (2013).

1. A process and performative view on social life: structures and institutions are realized through practices; practices are local and timely and they have histories.

2. The critical role of materiality of human bodies and artifacts; there are no practices without them.

3. A different role of agency and actor than in traditional theories: 'homo practicus' is both the bearer of practices in his or her mind and body, and the one who produces the practices in action.

4. Seeing knowledge as a capability to act in practices in meaningful and productive way.

5. The centrality of interests and motivation in all human action and a corresponding focus on power, conflicts and politics.[45]

[45] Kari Kuutti/Liam J. Bannon: The Turn to Practice in HCI (2014), p. 3546.

2.3.1 Limitations

Kuutti & Bannon themselves note how the practice approach draws on social research theory that is lacking in reference to the role of *artefacts*.[46] This shortcoming is exacerbated in the context of a practice-based methodology aimed specifically at generation of new artefacts.

[46] Ibid., p. 3545.

Within the context of the methodology developed in this text, the situation is remedied by substantiating the Practice paradigm through Actor-Network-Theory (ANT). Human and non-human actors jointly become carriers of practice. Thereby, ANT's focus on artefacts is combined with an understanding of HCI processes compatible with the Practice paradigm. The approach is theoretically valid, for Reckwitz himself places Latour's theory within the practice-genus.[47] It integrates with discussed dimensions of practice through material-semiotics' focus on issues of performativity[48] and materiality.[49]

[47] Andreas Reckwitz: Toward a Theory of Social Practices: A Development in Culturalist Theorizing (2002), p. 245.

[48] John Law: After ANT: Complexity, Naming and Topology (1999), pp. 4, 7.

[49] Ibid., p. 4.

2.4 Boundary Objects

Social scientist Susan Leigh Star and philosopher James R. Griesemer introduce the notion of *boundary objects* in their seminal study on institutional ecology.[50] These are conceptual entities allowing for cooperation in the *absence of consensus*.[51] A boundary object allows for participants to alternate between well-specified and more open versions of itself. By going back and forth between the well-specified object and an object open for interpretation, multiple communities can make

[50] Susan Leigh Star/James R. Griesemer: Institutional Ecology, 'Translations' and Boundary Objects (1989).

[51] Beth A. Bechky: Sharing Meaning Across Occupational Communities (2003).

use of the boundary object. Disciplines in need of exactness use the well-specified version, while other communities are able to appropriate the object for their respective needs.

The concept of the boundary object integrates both with the account of knowledge developed within the Practice paradigm and the aforementioned dimensions of practice. Knowledge embodied within boundary objects is not seen as representation of a state of affairs. Rather, boundary objects act through modulating practice, providing knowledge by supplying the ability to perform disciplinarily situated activities (fourth dimension).

Their relationship to interests and power dynamics has been worked out as well, thereby referencing the fifth dimension of practice. Huvila[52] provides a discussion of boundary objects in connection with political theory. Development of boundary objects is seen as an activity that is by no means 'neutral', for their creation usually furthers specific interests and agendas. Following this argumentation, both disciplinary use and construction of boundary objects should be construed with reference to the fifth dimension of practice discussed above.

[52] Isto Huvila: The politics of boundary objects (2011).

The concept of boundary objects has been applied successfully within the contexts of CSCW,[53] HCI,[54] and design.[55] Boundary objects allow for cooperation to unfold in an interdisciplinary setting in the face of dissensus. They inform practice without enforcing strict shared perspectives on objects and processes, thus lessening communicative restrictions within project teams. The enabled interpretive flexibility allows for artefacts to be construed in line with disciplinary theories and epistemologies.

[53] Charlotte P. Lee: Boundary Negotiating Artifacts (2007).

[54] Ernesto G. Arias/Gerhard Fischer: Boundary objects (2000).

[55] Gloria Mark/Kalle Lyytinen/Mark Bergman: Boundary objects in design (2007).

The ability of boundary objects to facilitate joint practices in the absence of consensus constitute a vital part of the interdisciplinary methodological framework developed in the present thesis (see chapter 8).

2.5 Methodological Implications

Wakkary's conception of complexity points towards the situational and interactional nature of everyday phenomena.[56] Its

[56] Ron Wakkary: Framing complexity, design and experience (2005), pp. 74–75.

situational nature necessitates development and evaluation within concrete contexts of use. It thus calls for practices that directly manipulate relevant social phenomena within a continuous process of incremental development.

Latour's theory and its history of interpretation within HCI offer the possibility of an interpretation of digital artefacts practicable within computer science, social research and design. Adoption of the concepts complexity and complication has a direct impact on the level of methodology: If development of interactive artefacts is conceptualised as a back-and-forth movement between complexity and complication, methodological pathways for both directions have to be provided.

Star describes a family of conceptual objects that facilitate cooperation in the absence of consensus. It thus calls for the development of conceptual devices that remain flexible enough for disciplines to appropriate them according to their specific requirements. At the same time, they have to be stable enough across contexts of interpretation to facilitate communication.

3
Methodological Backdrop

THERE ARE CIRCUMSTANCES WHERE THE BEST OR ONLY WAY TO SHED LIGHT ON A PROPOSITION, A PRINCIPLE, A MATERIAL, A PROCESS OR A FUNCTION IS TO ATTEMPT TO CONSTRUCT SOMETHING, OR TO ENACT SOMETHING, CALCULATED TO EXPLORE, EMBODY OR TEST IT.

– LEONARD BRUCE ARCHER

Substantiating the practice turn through a focus on artefact creation necessitates specification of an adequate methodological base. On the level of theory, actualising practice theory through Actor-Network-Theory, allowed to conceptualise the relationship between complex cultural practices and complicated digital artefacts. Building on the developed theoretical foundation, the methodological styles of reflective practice and practice-based research are combined into an apposite frame for shaping digital practices of making.

3.1 Reflective Practice

A first contribution is provided by the concept of *reflective practice*. Within the disciplinary context of HCI, Sengers et. al. contextualise reflective practice as a research style that combines technical and critical reflection activities.[1] It calls for continuous reflection on the theoretical, social and epistemological con-

[1] Phoebe Sengers/John McCarthy/Paul Dourish: Reflective HCI (2006), p. 1683.

ditions of one's research and making practices[2].[3] As such, it comprises reflection on questions of values, ontology, and the status of theory itself.[4]

Conceptualised as research *style*, reflective HCI is employed as a term grouping a multitude of critical approaches spanning a wide array of disciplines. Within the context of this discussion, I focus on approaches oriented towards construction of artefacts. Consequently, methodologies are sought that are able to underwrite practices of cooperative construction and making. They need to be able to ground not only processes of artefact creation but also the argumentation and negotiation processes driving the cooperative construction process.

Among the reflective practices, the paradigm of *Practice-based research* stands out as an approach centred on the aspect of knowledge generation through artefact creation.

[2] Donald A. Schön: The reflective practitioner (1983).
[3] Paul Dourish et al.: Reflective HCI (2004).
[4] Phoebe Sengers/John McCarthy/Paul Dourish: Reflective HCI (2006).

3.2 Practice-Based Research

Practice-based research is a variegated emerging methodological paradigm, providing a synthesis of artefact production and continual reflection. Common among various varieties of practice-based research is the primacy of *making* within a research process encompassing reflective theory building and interpretation. It thus provides a set of methods, integrating production of *concrete artefacts* into processes of critical reflection. Thereby, practice-based research allows for construal of artefacts produced as part of a process of ongoing conversation and argumentation.[5]

A wide array of strands of practice-based research exist,[6] rendering choice and adoption of respective methodological components exceptionally challenging. Consequently, teams and individuals willing to employ the methodology have to actively appropriate it, situating it within the specific affordances of design situations and project contexts.

[5] Maarit Mäkelä: Knowing Through Making (2007).
[6] Stephen Scrivener/Peter Chapman: The practical implications of applying a theory of practice based research (2004).

Technology research projects	**Creative-production research projects**
Artefact is produced.	Artefact is produced.
Artefact is new or improved.	Artefact is of high quality and original in a cultural, social, political or/and aesthetic, *etc.*, context.
Artefact is the solution to a known problem.	Artefact is a response to issues, concerns, and interests.
Artefact demonstrates a solution to problem.	Artefact manifests these issues, concerns, and interests.
The problem is recognised as such by others.	These issues, concerns, and interests reflect cultural, social, political or/and aesthetic, *etc.*, preoccupations.
Artefact (solution) is useful.	Artefact generates apprehension.
Knowledge reified in artefact can be described.	Artefact is central to the process of apprehension.
This knowledge is widely applicable and widely transferable.	The creative-production process is self-conscious, reasoned and reflective.
Knowledge reified in the artefact is more important than the artefact.	Knowledge may be a by-product of the process rather than its primary objective.

Table 3.1: Characteristics of Technology Research and Creative-Production Projects - Reproduced from (Ashley Holmes: Reconciling Experimentum and Experientia [2006])

3.2.1 Approaching Practice-Based Research

Computer scientist and design scholar Stephen Scrivener provides a first framework for construal of practice-based research.[7] Discounting the ability of artefacts to speak for themselves and thus count as research outcome, irrespective of activities of interpretation or evaluation, he works to establish a set of criteria for research oriented artefact production. In explicit contradistinction to design researcher Nigel Cross,[8] Scrivener stresses the necessary specificity of developed criteria to a set of activities. He discounts the possibility of developing a concept of research that is general enough to span contexts and disciplines while retaining the specificity for excluding non-research activities. No context-invariant definition of re-

[7] Stephen Scrivener/Peter Chapman: The practical implications of applying a theory of practice based research (2004).

[8] Nigel Cross: Design as a Discipline (2006).

search is available, Scrivener states. Accordingly, he discounts Cross's set of criteria on account of their abstract nature. Any attempt at trying to outline the practice of research, irrespective of its specific context, will only yield definitions so abstract that they invariably match activities not related to current and relevant practices of research. Consequently, criteria for research have to be developed in relation to a certain field such as technological research or artistic artefact creation. It is in this context that Scrivener's criteria for practice-based research have to be construed.

Furthermore, Scrivener explicates criteria for rigour in relation to practice-based endeavours:[9] First, rigour in on-the-spot experimentation calls for reflective reframing of situations. Secondly, rigour demands of a researcher to impose a consistent theoretical structure on situations in order to produce the possibility of surprise through expectation. Thirdly, rigour demands engaging in a reflective process of constant description, analysis, and reflective redescription of encountered phenomena.

[9] Stephen Scrivener/Peter Chapman: The practical implications of applying a theory of practice based research (2004).

Explicating a clear theoretical framework is a crucial precondition for the process. Conversing with the situation in the sense of Schön[10] is only possible in the face of clearly reflected expectations and theoretical guidelines. The situation does only 'talk-back' to a researcher approaching it with strong, theoretically informed expectations. Consequently, conversing with the situation requires both tuning of sensitivity towards its intricacies as well as confronting it with informed expectations and conceptual clarity.

[10] Donald A. Schön: The reflective practitioner (1983).

With explicit reference to qualitative research practice, Scrivener introduces reflexivity as a cyclic process of description, analysis and reframing.[11] In order to count as research, a creative production process has to be embedded within a process of scholarly reflective discussion.

[11] Steven Scrivener: Reflection in and on Action and Practice in Creative-Production Doctoral Projects in Art and Design (2000).

> It is therefore important that the creative production process is self-conscious, rational and reflective.[12]

[12] Stephen Scrivener/Peter Chapman: The practical implications of applying a theory of practice based research (2004), p. 4.

It has to be stressed how Scrivener employs a broad conception of an artefact. His discussion designates tools and tech-

niques as artefacts that facilitate some kind of action, as well as tools and techniques that facilitate creation of other tools or artefacts.[13] In this sense, methodological building blocks themselves can be considered as artefacts of practice-based making processes. This does make conceptual sense when viewed from the angle of ontological parsimony. Within the context of the present discussion, methodological elements that are constantly updated within a reflective process could be discussed on par with digital technology artefacts. At the same time, foundational theoretical elements and methodological commitments not part of the reflective process would not be part of the artefact. However, Scrivener does not seem to make this connection himself.

[13] Steven Scrivener: Reflection in and on Action and Practice in Creative-Production Doctoral Projects in Art and Design (2000), p. 17.

Finally, Scrivener develops a set of distinct criteria for what he calls *creative production* projects, setting them apart from traditional technology research endeavours (see table 3.1). He thus differentiates projects by the different status produced artefacts occupy within them. Within technology oriented projects, artefacts embody knowledge acting as solution to a supposedly preexisting clear-cut problem. Artefacts created within creative production processes have to be original and generate apprehensions pertinent to social, political, aesthetic or other cultural issues.

3.2.2 Hybrid Projects

Digital media scholar Ashley Holmes questions the comparably strict distinction between technology research and creative production projects underwriting Scrivener's discussion.[14] Holmes shows how projects within the domain of new media usually fall between both categories.

[14] Ashley Holmes: Reconciling Experimentum and Experientia (2006).

The text departs from a seemingly clear cut distinction: Scientific, *technology focused projects* adopt an experimental focus. They are driven by hypotheses and construct artefacts as solutions to clearly defined and widely accepted problems. *Creative projects* focus on experiential qualities, are driven by social and politically situated motivations. Artefacts produced

manifest issues and concerns pertinent to these experiential qualities.

During the course of his discussion, Holmes partially deconstructs the distinction between projects exhibiting technology orientation and creative focus. As an example, it is not at all atypical for produced artefacts within technology focused projects to both demonstrate the solution to a problem, while also manifesting cultural concerns and interests to a limited degree. Holmes goes on to develop the notion of a *hybrid project*, embodying both an interest in technology as well as constructive practice. The hybrid project engages the material of technology in a creative manner, through construction of digital artefacts.

The expounded conception of the hybrid project entails an intertwinement of two modes of operation. The iterative and reflective question-shaping, characteristic of practice-based research projects, is combined with a focus on the complicated issues of technology.

> [...] it was only through the rigorous practical engagement with the technological issues at hand, in tandem with a sustained scholarly reflection, that the questions that turned out to be important in relation to the endeavour revealed themselves.[15]

[15] Ashley Holmes: Reconciling Experimentum and Experientia (2006), p. 13.

In this sense, the hybrid project is differentiated against projects with an exclusively experimental focus. While these are guided by hypotheses and questions supposedly defined beforehand, the practice-based project orients itself towards a constructive interest. Reflecting on his practice-based projects, Holmes states that at the "outset there were a set of objectives for the production of an artefact."[16] These are updated successively within the outlined process of critical reflection. There are structural similarities to certain forms of grounded theory practice, particularly that of theoretical sampling.[17]

[16] Ibid., p. 6.

[17] Anselm Strauss/Juliet M. Corbin: Basics of qualitative research (1990), pp. 134–147.

Holmes embeds his discussion within a meta-theory based on science-and-technology scholar Andrew Pickering's text *The Mangle of Practice*.[18] Pickering develops his theory in response to Actor-Network-Theory, incorporating and adopting many of Latour's ideas. However, Pickering retains a firm distinction

[18] Andrew Pickering: The Mangle of Practice (1995).

between agency of human and non-human provenance, between human agency and *material agency*. While these forms of agency are differentiated against each other on an analytic level, Pickering puts them on an equal footing. Both have to be analysed in order to describe and understand phenomena of scientific conduct and technology development. In any case, Holmes focuses on the notion of material agency within his discussion of Pickering. The distinction from human agency is employed in order to highlight the constitutive role of artefacts, systems, of machines and tools which enter into a relationship of intertwinement with human agency. Consequently, Holmes' approach can be read against the background of the Practice-paradigm substantiated through Latourian theory as long as we remain mindful of the different accentuation present within Holmes' choice of meta-theoretical framing.

Hence, Holmes' conception of a hybrid project is useful as a reading of practice-based research that accommodates a focus on technology. Through its reference to Pickering's concept of material agency, it is rendered compatible to the developed theoretical grounding in Latourian practice theory and complexity.

3.2.3 Artefact and Interpretation

In her text *Knowing Through Making*,[19] Maarit Mäkelä provides an account of artefact making as process of argumentation.

[19] Maarit Mäkelä: Knowing Through Making (2007).

Mäkelä stresses the importance of interpretation within the practice-based process (called practice-led within her text). Artefacts in themselves are seen as "mute objects", containing the mere *potential* to be read as narratives or arguments. Not entirely unlike Holmes, Mäkelä's discussion contains experience as a central category, referring to de Lauretis' construction of the concept.[20] Furthermore, Mäkelä argues for a well-structured process in order to create the requisite regularity for sustaining an ongoing interpretive process.

[20] Teresa de Lauretis: Alice doesn't (1984), p. 159.

Choice of method is subjugated under the ongoing pursuit of research questions within Mäkelä's research frame. Since relevant questions cannot be known in advance, it is not possible

to specify adequate methods before engaging with the actual material of a practice-based research process. Rather, Mäkelä argues for formulation of a *research frame*, specifying guiding questions that serve to direct the practice-based journey.[21] Only in relation to questions tied to that frame is an informed choice of methods possible. Construed in this manner, artefacts can be read and interpreted as arguments and as response to questions.

[21] Maarit Mäkelä: Knowing Through Making (2007), p. 160.

Consequently, Mäkelä's discussion is useful in the context of hybrid projects in order to construe processes of making as processes of argumentation. The expounded position, highlighting the primacy of making, however, leaves the origins of artefact creation largely unspecified. Mäkelä argues that theory does not found the creative process but instead serves to contextualise its products. The foundation of said process consequently remains in the dark. While this is a criticism that could be levelled at much of practice-based literature, it is compensated in other conceptions through adoption of a more circular-iterative outlook on the research process.

3.2.4 Practice-based or Practice-led

Up to this point, this text has not clearly differentiated between the signifiers *practice-based* and *practice-led*. The resulting ambiguity is not coincidental – indeed, considerable terminological confusion surrounds these respective terms. Some authors, such as Gray,[22] treat them as interchangeable. Others, such as Mäkelä and Scrivener prefer one over the other.

[22] Carole Gray: Inquiry through practice (1996).

For the purposes of this thesis, I will depart from Linda Candy's proposal for differentiating both terms:[23]

[23] Linda Candy: Practice based research (2006).

- If produced artefacts form an integral basis of a research process, it is called *practice-based*. Research outcomes and knowledge claims must be understood in relationship to objects created.
- Within an *practice-led* endeavour, artefact construction is employed as method within an overarching research pro-

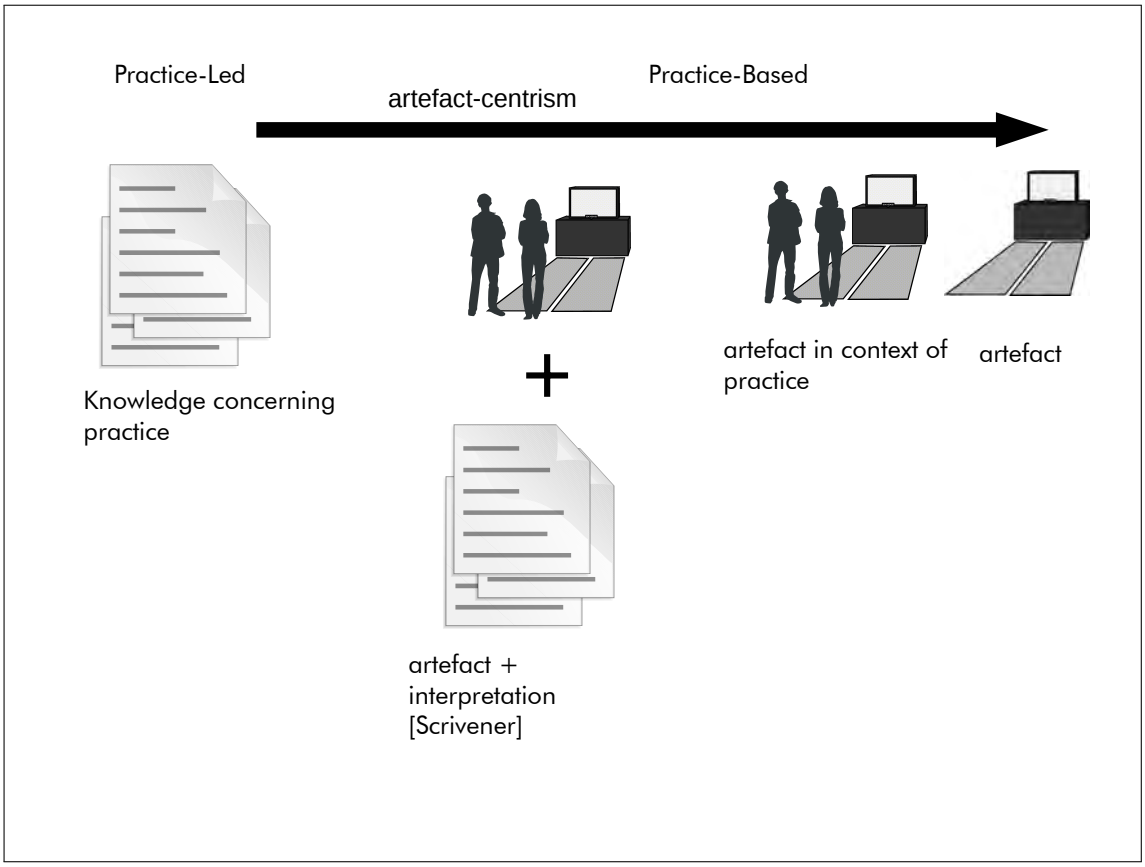


Figure 3.1: Practice-Oriented Research Continuum

cess, leading to results that can be understood independently from artefacts produced.

Resultingly, in the case of a practice-based process, knowledge produced is embodied by artefacts created, at least to some degree. Indeed, I conceive of the difference practice-based/practice-led as one of degree, rather than as clear-cut binary distinction. Depending on whether a research endeavour mainly inscribes its knowledge within artefacts or chooses to focus on patterns of practice facilitated through artefact creation and artefact use, it tends to be more practice-based or practice-led. Consequently, I conceptualise practice-orientation as a continuum between idealised poles of practice-based or practice-led projects (see fig. 3.1).

3.3 Methodological Bootstrapping: Towards a Methodology for Interdisciplinary Prototyping

The preceding sections have provided necessary methodological background and building blocks. At the same time, it has to be stressed that neither of the methods and approaches directly address or solve the problematic of interdisciplinary prototyping in cultural contexts. Furthermore, the majority of approaches want to be construed as paradigms or methodological interventions, not as ready made frameworks, suitable for straightforward application. They usually require practitioners to work out their own methods, even if they choose to subscribe to one of the presented paradigms.

Engendering awareness of this methodological background is crucially important, however, for it enables a dialogue between project participants' positions and the rich experiences of established researchers and practitioners. In fact, approaches thus far described acted as theoretical and methodological lenses through which interdisciplinary prototyping efforts could be analysed. They provided helpful conceptual frames and adequate points of departure, in order to facilitate negotiation of a viable methodological structure.

Crucially, none of these methods obviates the fundamental divisions between disciplinary cultures. While some methods, notably within the field of HCI, try to straddle disciplinary boundaries, fundamental differences remain. In fact, within projects I observed, social researchers were often dismayed at the way HCI had appropriated their methodologies. They dismissed or actively resisted subsumption of their methods under the goals of artefact creation. A common point of contention was how fields such as HCI misrepresent complex epistemological claims embedded within disciplinary practices.

At the same time, developers appeared to voice frustration. Social research methodology seemed to hold the key to the complex problematic of analysing cultural phenomena. Yet, at the same time, it did not seem willing or able to translate its insights into languages accessible to digital makers. If indeed

some unbridgeable epistemological and methodological disconnect separates them from the realm of digital-constructive practice, how could they ever enter into dialogue? The question of how to construct a methodology able to explore the rich world of the social while retaining the ability to construct complicated digital artefacts appeared as an open one.

Mäkelä's distinction between artefacts as "mute objects" and interpretation provides a way forward: Artefacts themselves can enter into processes of argumentation, if they are paired with requisite practices of interpretation. Mäkelä thereby preserves the autonomy of the artefact, while highlighting the crucial importance of practices of interpretation.

In this manner, I conceptualised an interdisciplinary project of making to simultaneously unfold on two levels: One process of *material argumentation*, driven by artefact construction, paired with processes of discursive argumentation unfolding on levels of discussion and theory production. Both are linked through activities of interpretation of produced artefacts.

In order to understand the relationship between digital artefacts and social practices, the conceptual pair of complexity + complication is helpful. It also allows for a productive reformulation of the activities of computing professionals: They act as experts of complication, are versed in methods for crafting and controlling complicated artefacts. Accordingly, interdisciplinary activities can be conceptualised as productive back and forth movement between complexity and complication.

Reflective HCI and critical technical practice are especially helpful in showing how interpretation of digital artefacts can inform development processes.

The methodological desideratum thus is a methodology able to unfold in the face of disciplinary diversity and antagonistic epistemological commitments. To this end, I embarked on a process of "methodology making", developing a methodological prototype that was continuously modified as part of practice-based processes of making.

These efforts ultimately culminated into the DivE methodology, discussed in chapter 8.

The germinal structure of the methodology is as follows:

- Project activities are organised into iterations.
- Each iteration should ideally comprise practices of reflection, construction or alteration of an artefact, paired with evaluation of said artefact in a situation of use.
- Project participants seek to sensitise each other towards their respective disciplinary interests, terminologies, methodological and epistemological commitments, and idiosyncratic goals.
- Participants do not try to “come to terms”, in the sense of an agreement on a common language, common epistemology, or shared theory. Rather, within every iteration they try to frame their differences in a way that allows them to construct or alter the common artefact.
- Participants invite each other to produce interpretations of artefacts constructed. Differences on this level of interpretation are not framed as problematic.
- Within each iteration, participants eventually agree on a common course of action, regarding the desired future material configuration of the joint artefact.

These incipient methodological commitments were then constantly tested and improved upon within concrete interdisciplinary making processes.

The structural template just outlined served as first methodological prototype during concrete practice based processes. This in turn implies a special self-reflexive relationship between making projects and the process of methodology-making that informed them: Neither is DivE a mere result of concrete projects that informed its genesis nor can individual projects be extricated from the constitutive process of co-evolution that link them to the incipient methodology.

In order to follow the trajectory of the project itself and thus render the practice-based process intelligible, I will first describe concrete making projects during whose development DivE was created.

4
Implementation + Prototype Ecology

BUT A METHOD POSSESSES THE PECULIAR QUALITY THAT, VIEWED ABSTRACTLY, IT IS NOTHING AT ALL; IT IS A METHOD PRECISELY IN THE PROCESS OF BEING CARRIED OUT;

– SØREN AABYE KIERKEGAARD

Interdisciplinary development of interactive artefacts aimed at supporting cultural practices was developed as a problematic necessitating continual and conflictual retranslations and renegotiations between complex processes and complicated structures. During the course of preceding chapters, an incipient methodological structure and theoretical vocabulary were specified, able to facilitate adequate processes of construction and development.

It has to be stressed that this discussion does not describe a mere application of a developed, preexisting methodology to a specific instance or problematic. In line with the adopted practice-based stance, the methodology itself becomes part of negotiations – as such, its concepts describe a basic structure which is both substantiated and reaccentuated during practices of joint artefact construction. The resulting, more fully developed, methodology is described in chapter 8.

4.1 Prototype Ecology

Conception of the prototype ecology is based on an analysis of the practice of an exhibition visit. Building on this analysis, a framework is explicated acting as foundation for prototypes discussed in subsequent chapters.

Development was conducted within the interdisciplinary Research Training Group crossWorlds[1] at Chemnitz University of Technology. Project activities aimed at creation of the prototype ecology were aided by qualitative social researcher and rhetorical scholar Kalja Kanellopoulos and master's candidate Linda Pfeiffer. Empirical evaluations were conducted in cooperation with social researchers, while I designed and implemented the system's digital components within a self-contained iterative development process.

[1] http://gepris.dfg.de/gepris/projekt/191845130

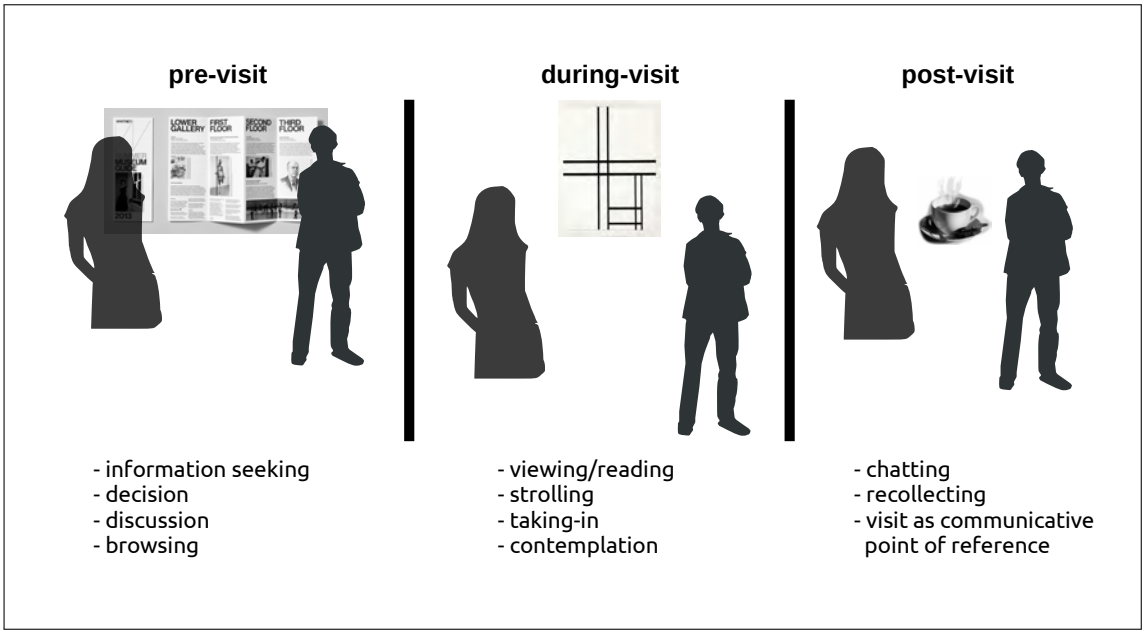


Figure 4.1: Exhibition Visit – Model of three-partite Structure

Three Phase Model

In coordination with qualitative social researchers a phase model of an exhibition visit was developed (fig. 4.1). According

to the model, the practice of a museum visit exhibits a three-partite structure:

- *Preparatory phase* - Potential visitors learn about the exhibition and decide in favour of a visit. This phase encompasses practices of information seeking via smartphones, web-based interfaces, advertisements, catalogues, or word of mouth.
- *Visit phase* - Visitors take part in the exhibition itself. During their visit, they interact with exhibits and each other. Practices such as taking in impressions, contemplation, discussion, strolling, getting lost, reading of guides, posing questions, and taking pictures are part of this phase.
- *Follow-up phase* - The exhibition visit remains as communicative point of reference. Antecedent to the visit, individuals discuss their experiences. Chats over coffee, posting of pictures, conducting additional research using dictionaries or textbooks, and discussions online are part of this phase.

Prestudy – Museum Artefact Ecology

Following the theoretical framing adopted (see 2.2) humans and artefacts jointly become carriers of outlined practices.[2] In order to modulate said practices in a way promoting processes of education and self-cultivation [3], the whole assemblage of human and non-human elements in each practice has to be taken into account.

I conducted a prestudy in collaboration with Pfeiffer in order to validate and expand on the developed understanding of museum visits. The initial focus of prototyping projects were exhibition contexts within museums. The prestudy itself was conducted towards the end of sensitising the team towards the situational specifics of exhibition visits. A series of eight semi-structured interviews were conducted.

Based on the prestudy, additional participant observations, literature surveys, and discussions with social researchers at the crossWorlds group were conducted. Observations and

[2] Bruno Latour: Reassembling the Social-an Introduction to Actor-Network-Theory (2005).

[3] The goal adopted by project participants was that of furthering “Bildung”, a German term usually translated as “education”. Separate from the idea of training its focus is on the development of character, responsibility and sensitivity rather than acquisition of know-how and skillsets.

discussion was conducted at the Saxon Museum of Industry in Chemnitz, Germany[4], and Ars Electronica Center in Linz, Austria[5]. Observations made during prestudy and additional observations informed formulation of a classification of the role of artefacts within practices of exhibition visits. Artefacts are grouped into six categories, according to their role regarding the examined practice:

[4] http://web.saechsisches-industriemuseum.com/en/chemnitz.html
[5] http://www.aec.at/center/en/

- *Referents* - The main foci of attention within practices of exhibition visits. These can be exhibits itself, interactive installations, reproductions, or other elements.
- *Scuttlebutt* - Sites of congregation, allowing for discussion and narration among fellow visitors. These sites of discussion can be online or offline, allowing to bring together material and virtual artefacts. Tangible UI installations and sitting areas are examples of this category.
- *Personifier* - Elements of this type allow visitors to leave marks within the environment. Visitor's books, bulletin boards, social media interfaces, and (illicit) scribblings are examples of this category. A particularly noteworthy example is the shadowgram installation developed at Ars Electronica Futurelab.[6]
- *Recollector* - Elements of this type further the capacity of memory antecedent to the visit. They allow visitors to remember and relate bits of information in a lasting manner. Examples comprise take-aways such as reproductions, maps, and accessories.
- *Connector* - Elements of this type serve to relate different impressions or bits of information during the visit. Examples comprise handwritten notes and museum guides.
- *Lenses* - Elements of this type facilitate assuming multiple perspectives in relation to the subject matter. They allow to experience narratives from multiple perspectives, thus pointing to the complex nature of presented material. Examples include conflicting historic source texts, first hand witness

[6] Hideaki Ogawa et al.: Shadowgram (2012).

accounts, photographs, narrations of contemporaries of historical processes.

Prototype Ecology – Selected Prototypes

Antecedent sections have given a brief global overview of the developed prototype ecology. A selection of developed prototypes is discussed in subsequent chapters:

- PRMD – an interactive digital prototype exploring the concept of historical biographical narrative. PRMD is discussed in chapter 5.
- ASSMBLG[7] – a low-fidelity digital prototype exploring the role of materiality and tangible interaction patterns within the museum domain. ASSMBLG is discussed in chapter 6.
- PRTL – a practice-led project focusing on digital prototypes aggregating and displaying information from the social web. During the course of this project, digital artefacts were developed that actively facilitate negotiation of computing and coding practices. PRTL is discussed in chapter 7.

[7] Technical infrastructure and study design of this prototype were developed by Linda Pfeiffer.

The rationale for selection is illustration both of the scope of the adopted DivE-methodology and a structured inquiry into the concept of practice itself. Furthermore, projects are selected in order to cover several of the dimensions of practice introduced in section 2.3. PRMD as well as PRTL point towards the performative dimension of practice, while ASSMBLG focuses on the material dimension. The fifth dimension, namely the relationship between practice and conflict and power dynamics, possesses a special level of significance with respect to the developed methodology, as the DivE framework is based on the idea of rendering communicative frictions productive. Apart from the focus on conflict inhering within the DivE methodology itself, and thus running through all projects discussed, this 'power-dimension' of practice is foregrounded in the course of the PRTL project. Two of the projects, PRMD and ASSMBLG, were developed in the context of the crossWorlds research training group on the basis of study results outlined in

the present chapter. The PRTL prototype was developed, evaluated and exhibited in close collaboration with design ethnographer and community artist Vicki Moulder at the Everyday Design Studio at Simon Fraser University in Canada.

4.2 Middleware Prototype Implementation

Development of the system's middleware component was driven by the need to address a high level of heterogeneity both on the levels of technology and social communication: Technical literacies were quite unevenly distributed among project participants, which in turn created heterogeneity on the level of perceived requirements: Some participants called for simple, self-explanatory interfaces in a bid to keep systems as simple as possible. Others insisted on powerful interfaces, allowing them to demonstrate their level of technological sophistication and skill. Ultimately, I decided to confront these challenges through a layered system architecture, offering individual interfaces, requiring different degrees of technological sophistication.

Designerly participants were predominantly interested in developing frontend-UI components while being versed in technologies such as `Hypertext Markup Language`, `Cascading Style Sheets` and `JavaScript`. Computer scientists were more interested in designing the system's business logic, and low- and mid-level components using languages such as `Scala`, `Java`, `C++`, or `C#`.

LOOPHOLE, an architectural prototype

LOOPHOLE serves as middleware component within the developed prototype ecology. It thus is responsible for connecting system components within distributed deployments in a manner minimising architectural overhead.

System architecture facilitates connection of, possibly distributed, sensors and presentation devices. Sensors comprise devices such as microphones, cameras, and multitouch-

surfaces. System output should be available via mobile and stationary presentation devices, such as smartphones, desktop and single-board computers, driving projectors, monitors or other output devices.

Different stakeholders should be able to modify system behaviour through manipulation of discrete system elements. Plasticity of the system as a whole should be high enough to allow for the system to cope with removal and manipulation of single elements.

Prototype Design

The system provides facilities for loose-coupling of components. Communication takes place via network connections, facilitating long-distance coupling.

Responsibilities within the system are distributed among three layers:

- Presentation Layer
- Application Layer
- Sensing Layer

The system consists of a JVM based backend written predominantly in Scala and a Web-based frontend realised via HTML5+CSS3+Javascript. Both components communicate in real-time via a Websocket[8] connection (see fig. 4.2, top left).

[8] I. Fette/A. Melnikov: RFC 6455 (2011).

Serialisation of messages is facilitated via JSON, which is used for local file-system storage as well. A CouchDB based persistence layer was part of previous prototype instances. It was removed, since it added to the complication of storage management for project participants unfamiliar with database maintenance. The organisation allows for JSON records to be manipulated prior to node-start without managing additional persistency dependencies.

`Jackson`[9] is chosen as parsing library, while `Scala` specific mappings are provided via `jackson-module-scala`[10]. Bindings are provided for relevant message objects, via `Scala`'s `BeanProperty` mechanism.

[9] `https://github.com/FasterXML/jackson`
[10] `https://github.com/FasterXML/jackson-module-scala`

Cross-browser capable WebSocket server functionality is realised through the `Atmosphere` framework[11]. `Atmosphere` is based on the RESTful Web Service framework `Jersey`[12]. Every LOOPHOLE application creates an `Atmosphere` endpoint, allowing `WebSocket` capable clients to connect. Multiple applications can be active at the same time, receiving events through the LOOPHOLE infrastructure. State is managed on a per-application basis, multiple applications process events independently from one another.

[11] `https://github.com/Atmosphere/atmosphere`
[12] `https://jersey.java.net/`

Loose coupling[13,14] is employed as architectural style where possible. Sensors and nodes can be placed on different physical and logical machines – communication is facilitated via UDP. Sensor readings are relayed to nodes via multi- or unicast messages. Nodes contain sensor and/or presentation servers, thus forming a network of components.

[13] Doug Kaye: Loosely Coupled (2003), pp. 131 ff.
[14] Cesare Pautasso/Erik Wilde: Why is the Web Loosely Coupled? (2009).

Resource provision is managed through a quasi-independent subcomponent. It runs within its own `JVM`, starting parsing-threads on demand. Twitter and Flickr integration is facilitated through `Twitter4J`[15] and `Flickr4Java`[16] respectively. Retrieved text and image content is stored within a single resource pool.

[15] `http://twitter4j.org/en/`
[16] `https://github.com/callmeal/Flickr4Java`

Whenever possible, the file-system is employed as an interface between both components. While lacking in efficiency and portability, it is an interface that is easily understood by stakeholders possessing modest technical skills. Adaptors for processing of external data-inputs are present within the backend. Backend based processing produces categorisations that are mapped to file-system structures wherever possible.

Client logic is realised as `HTML5+CSS3+JS` application. Clients subscribe to the relevant `WebSocket`-server endpoint, subsequently receiving `JSON` serialised events. Client application logic, comprising event processing and UI generation are facilitated via `jQuery`. Client event handlers are specified on a per-message basis. Processing of incoming events is handled through the `socket.cw.js` component, responsible for

establishing a mapping between incoming events and client handlers.

Functionality such as coordinate transformations, rendering of date time scales, and other visualisation related features are realised through the `D3.js`-Data Driven Documents library[17]. It is also employed for `SVG` rendering as well as complementing `jQuery`'s document traversal functions.

[17] `http://d3js.org/`

4.2.1 Related Systems

Pure Data[18,19] (PD) is a visual programming environment for multimedia processing. It features a dataflow oriented programming language[20] with a visual interface, allowing for easy specification of input-output mappings as well as graph layouts. It furthermore allows for easy integration of sensor devices. Focusing on practices such as electronic music installations, PD provides a solution for distributed processing of sensor inputs.

[18] Miller Puckette et al.: Pure Data (1996).

[19] Miller Puckette: Pure data (1997).

[20] Wesley M. Johnston/J. R. Paul Hanna/Richard J. Millar: Advances in Dataflow Programming Languages (2004).

4.2.2 Future Work

At the moment, placing a sensor still requires it to be connected to a computer running a desktop operating system. While this can be facilitated using a netbook-device, placement of a large fleet of sensors thus entails considerable overhead. Consequently, the upcoming deployment scenario calls for utilisation of credit-card sized computers such as Raspberry Pi[21]. These can be installed using more efficient [22] driver infrastructure.

On a conceptual level, the infrastructure can be situated with reference to the *Internet of Things*.[23,24] This allows for a closer integration with objects within both the artefact's environment and the environment of users, such as wearables or installations within users' homes.

[21] `https://www.raspberrypi.org/`

[22] `https://github.com/xxorde/librekinect`

[23] Luigi Atzori/Antonio Iera/Giacomo Morabito: The Internet of Things (2010).

[24] Mark Weiser: The Computer for the 21st Century (1999).

4.2.3 Discussion

Heterogeneity and disciplinary complexity do not constitute mere operational contexts for development activities. Indeed, they can have profound implications for system design itself.

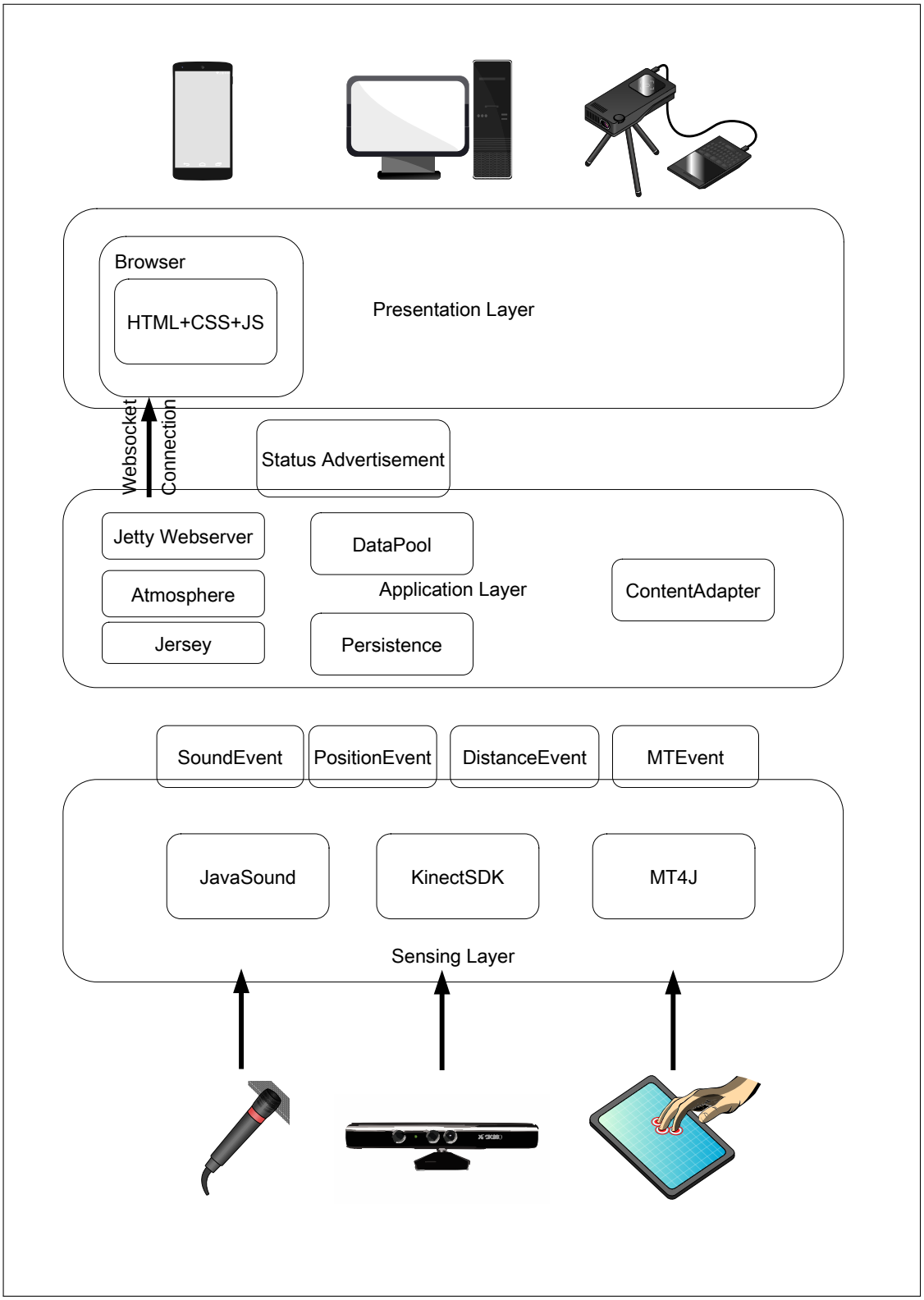


Figure 4.2: LOOPHOLE – High-Level Outline of Digital Components

Usually, system architecture serves the goal of minimising complication within the built artefact: Given a set of goals, system components are organised in a fashion exhibiting a minimal level of complication while meeting requirements. Introduction of superfluous complications quickly leads to unwieldy, unmaintainable, and incomprehensible designs. Accordingly, it is the task of skilled developers to facilitate translation of complex requirements into complicated structure, to anticipate future needs and specify architectural patterns able to

The requirements of a prototyping architecture for interdisciplinary development in a practice-based context present us with a fundamentally more involved picture. In order to facilitate hands-on participation, every stakeholder should be able to change the digital structure of systems produced. As the line between developers and users is thus deliberately erased, the set of requirements inevitably heterogenises. Components have to be segmented in a way that affords development by project stakeholders possessing differing skill sets. Resultingly, a prototyping architecture might diverge substantially from what would otherwise be designed within projects consisting of software developers. In this sense, project complexity invades the level of technological complication.

LOOPHOLE confronts this problematic through a layered architecture whose architectural requirements have been relaxed in order to permit easy access to less proficient team members. Less well versed participants are free to “productively misunderstand” the architectural pattern and introduce functionality in a manner temporarily circumventing prescribed logical structure. This indeed puts additional strain on developers: As other project participants keep introducing erroneous components and upset architectural structure, it is the developers’ task to “clean up” after them, restoring architectural consistency. In effect, LOOPHOLE becomes an architectural boundary object itself, connecting the discursive universe of software professionals with non-expert communities.

5
PRMD – Interactive Installation

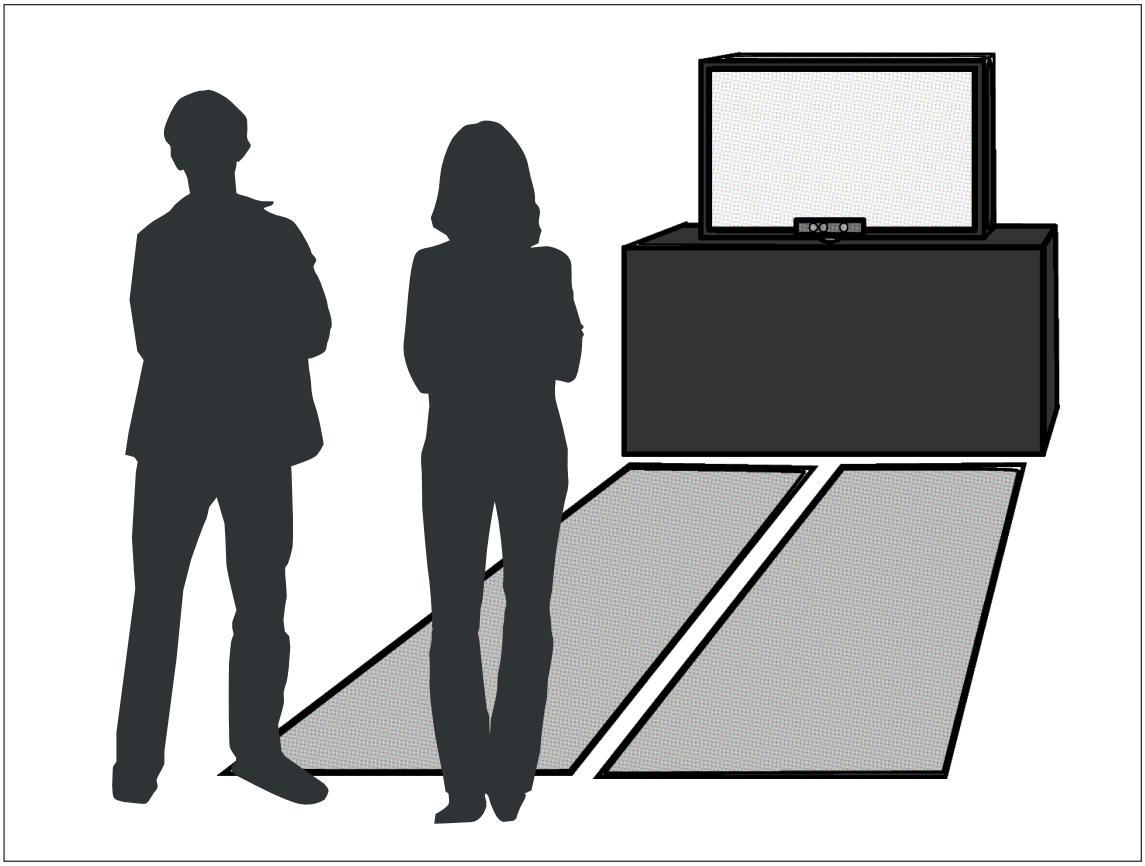


Figure 5.1: PRMD – A Prototype Exploring Performative Phenomena through Interactive Narration of Biographies

This chapter outlines development of the PRMD prototype. The developed installation allows users to experience biographical narration in pairs of two. The artefact thus encourages users to jointly adopt the roles of public historic persons. In the

engendered process, they jointly, through movement, explore a narration that highlights the junctures between both biographies.

The development project was guided by a reflection on the question of *performativity* (see section 9.1.2), especially regarding the relationship of users' identities and artefact-modulated patterns of interaction. Thus, it can be read as interrogation of the first feature of practice as described in section 2.3. Furthermore, the discussion details how theoretical devices developed in chapter 2 aid reconstruction of processes of prototype development and user behaviour. Final sections describe limitations encountered within the formulated conceptual apparatus during its application. Respective analysis of strengths and shortcomings is employed in order to provide impulses for further development of theoretical and methodological elements developed in the course of preceding chapters.

5.1 Motivation & Concerns

In line with the practice-based methodology, initial problem framings and relevant artefacts are subsequently described. The project departed from a concern with questions of *identity* and *user generated content* in relation to historical narratives: Regarding the emotional and ideological impact of historical narrative, the question who to identify with possesses a special level of importance. Furthermore, traditional museum environments construct a clear distinction between content creators and content receivers. Only curators and other museum staff are able to create narratives, while visitors have to follow their predetermined intellectual trajectories. Consequently, discussion at this stage was informed by the *Lenses* category developed earlier (see 4.1).

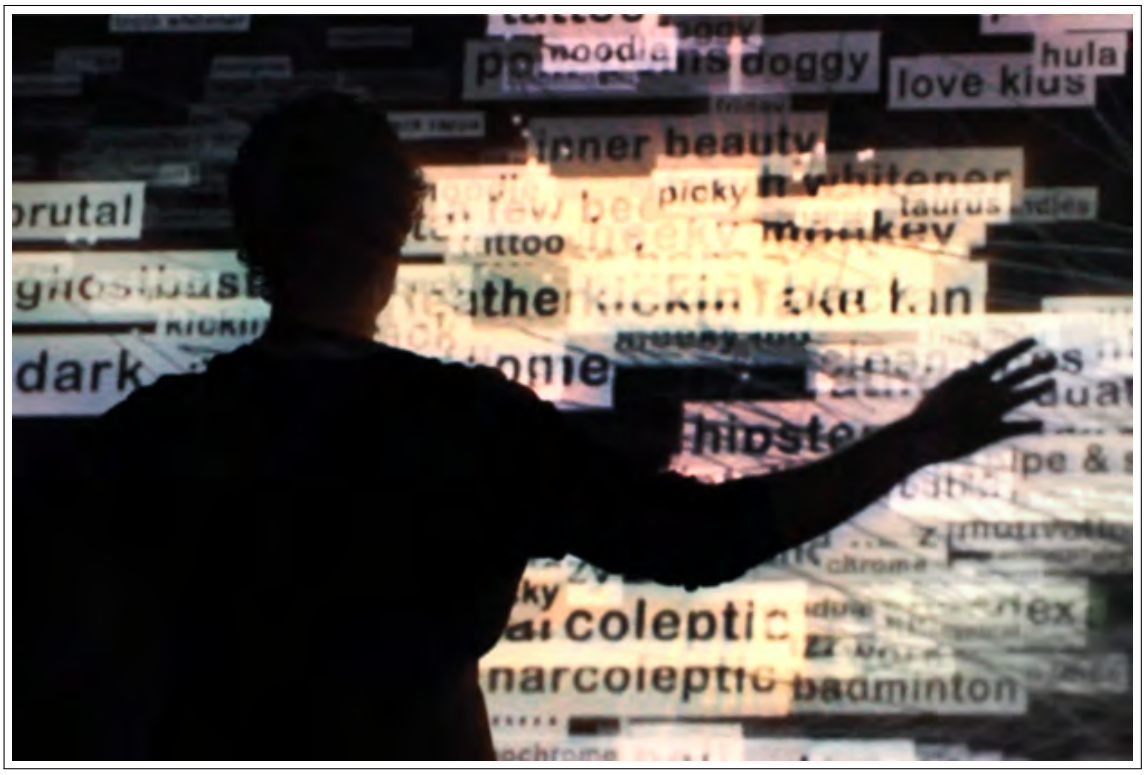
In the course of following sections, the iterative process of artefact creation is discussed.

5.2 C E L L

Development of the PRMD system was influenced by the installation C E L L,[1] providing a visualisation of online identities. C E L L is an interactive installation created by Alliban & Matsuda,based on full-body tracking realised via Microsoft Kinect.

[1] James Alliban/Keiichi Matsuda: C E L L (2011).

Interaction takes place in front of a large projection (fig. 5.3). The projection space is filled with a large number of word tags (fig. 5.2). Initially, these are kept in a state of slow random motion. As soon as a user is detected, associated skeletal data points are visualised in the form of a set of dots. Tags start gravitating to the associated dots, eventually sticking to them. After some time, a user's skeleton is coupled with a set number of tags, following her movements (fig. 5.4).



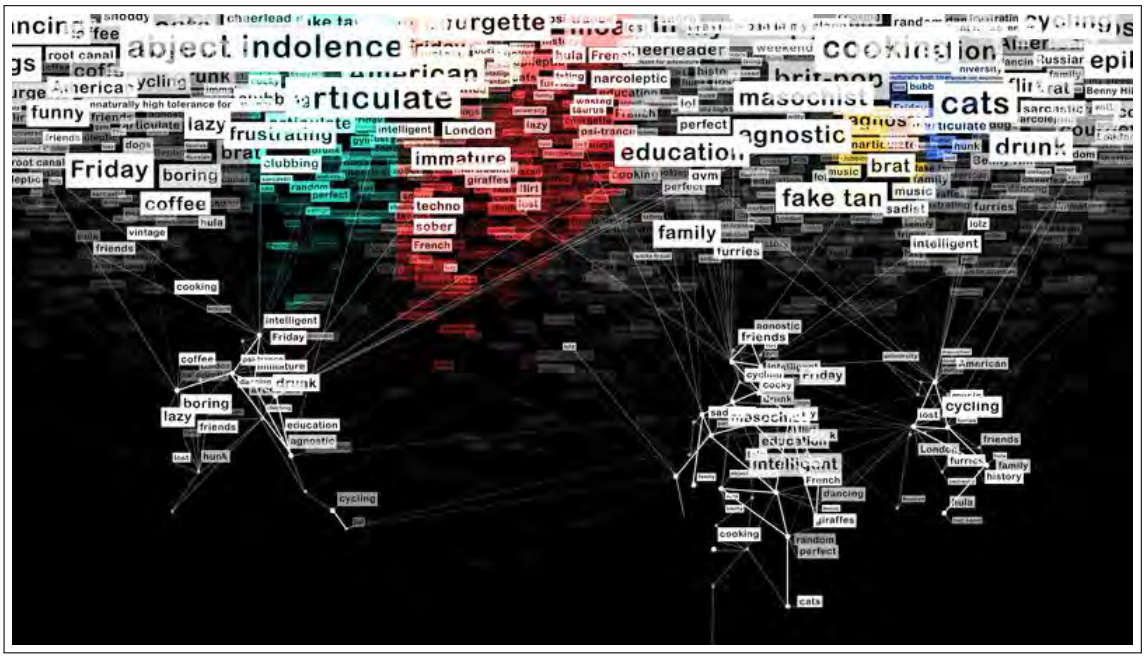


Figure 5.2: C E L L – Word Tag Display

Figure 5.3: C E L L – Interaction Patterns

Tags within the projection space are mined from online profiles present on social media platforms such as facebook. Mapping of identities to bodies is arbitrary: When detected by the C E L L-system, a human body is identified with a random identity composed of tags previously harvested.

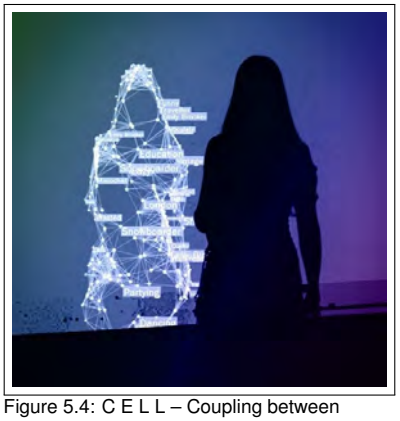


Figure 5.4: C E L L – Coupling between Body and Data

5.2.1 Discussion & Interpretation

C E L L encourages users to adopt the ephemeral role of a fictitious persona. As soon as multiple bodies are present within the interactive area, a performatively charged space is created, which renders transparent the prescriptive nature inhering within practices of self-description via social media.

The installation creates an impromptu identity which users automatically perform through the simple act of physical presence within interactive space. It thus points to the fact that users are performing a pseudo-random role assigned to them by the system. However, the setup does not enforce any other actions apart from physical presence. It does not allow for other actions, for accepting or repudiating the role given. The aspect of transparency points more towards privacy concerns than towards issues of performance.

C E L L operates by inducing a rift between users' familiar social role and their assigned identity. In tandem with the selection algorithm, they are forced to perform an identity alien to them which furthermore becomes transparent to any interlocutor with visual access to the presentation device. Role distance is among intended effects, as the presence of a selection algorithm is apparent to others.

The C E L L system can thus be construed as an instance of reflective practice. Developers themselves describe their intention as a reflective one: Users are encouraged to reflect upon the "commodification of identity".[2]Within the authors' interpretation of their work, the gradual character of establishing a mapping between body and data receives special attention.

[2] James Alliban: Cell (2011).

It is construed as a visualisation of the closing gap between "physical and digital selves".[3]

[3] Ibid.

An interesting aspect is the relationship with time. The installation presumably puts its users in a reflective, meditative mood, opposed to the hectic activities associated with management of one's online identity. This observation can be related to the mode of time created by the practice of online identity management itself.[4]

[4] Richard Harper/Eryn Whitworth/Ruth Page: Fixity (2012).

5.3 PRMD Development – Iteration #1

5.3.1 Development Context

The PRMD project was conducted in the context of the interdisciplinary research training group crossWorlds (see section 4.1). My development efforts were aided by research assistant and master's degree candidate Linda Pfeiffer. Digital development was conducted by me with exception of a sensor level component used for interfacing with MS-Kinect's SDK component. Apart from power differentials inhering within the supervisor/candidate dynamic, design decisions were conducted on an equitable basis. A joint reading of the theory of Embodied Interaction[5] informed discussion processes with Pfeiffer.

[5] Paul Dourish: Where the Action Is: The Foundations of Embodied Interaction (2004).

Developed by Paul Dourish, Embodied Interaction (EI) blends phenomenological thought with ethnomethodological methods in order to inform interaction design procedures. It is indebted to Lucy Suchman's seminal study *Plans and Situated Actions*[6] and Phil Agre's phenomenological approach to computing.[7] It can be reconstructed as a designerly application, reformulation, and extension of Suchman's approach in order to suit the demands of HCI discourse. EI provides a conceptual framework by identifying four distinct levels as candidates for analysis: intersubjectivity, ontology, intentionality, and coupling. It derives design principles from its phenomenological reflection which highlight the mediality of computing, thereby pointing to the necessity of examining the meaning of computer-based symbols in the context of concrete practices of use.

[6] Lucy Alice Suchman: Plans and Situated Actions: The Problem of Human-Machine Communication (1987).

[7] Philip Agre: The Dynamic Structure of Everyday Life (1988); Philip Agre: Toward a critical technical practice (1997).

Social researchers in the group, supplied empirical results and theoretical framings. Academic exchange with social researchers Kalja Kanellopoulos and Andreas Bischof proved to be especially valuable. Regarding these discussions, Latourian practice theory emerged as a shared point of reference.

5.3.2 Initial Motivation

Initial reflections focused on the relationship of *time*, *history*, *identity* and *experience*. How can historical distance be integrated into the limited time-frame of an exhibition-visit?

Preliminary observations generated by qualitative social researchers informed discussion of experiential parameters of user-system interactions. One preliminary result was that interactions with interactive artefacts usually are short (<1 - 5 min). It should be noted that some of these studies were conducted relatively independently from the described project. Consequently, they pursued goals not directly related to those of the PRMD team.

Historical identities had already been identified as an interesting medium for enabling historical experience. Consequently, experiential prototypes were developed, inviting users to engage in role-playing activities. However, prototypes allowing for free-form role playing did not seem to convey an adequate amount of structure within the exhibition context. During prototyping sessions, it was not clear how to provide users with clear instructions for adopting the role of a historical persona. In consequence, free-form prototypes exhibited prohibitively high degrees of complexity and complication. Respective material frames did not provide clear affordances for users and it remained unclear how to effectively convey subject matter within free-form role-playing situations.

More traditional approaches, based on projections and informational displays, seemed to better fit practices of exhibition visits. However, it was not clear how to realise the overarching goal of connecting users in the context of these more traditional setups.

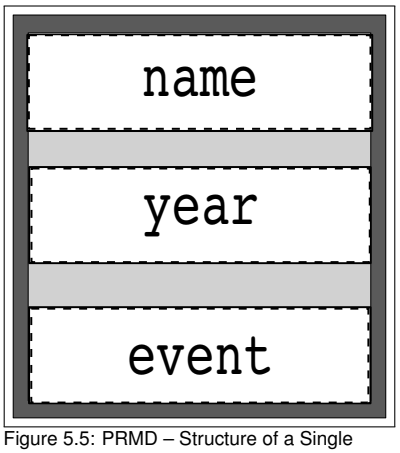


Figure 5.5: PRMD – Structure of a Single Card within mini-PRMD

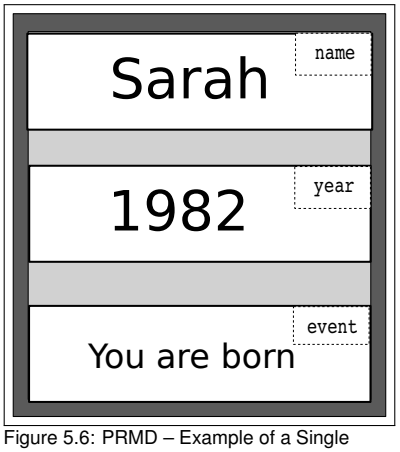


Figure 5.6: PRMD – Example of a Single Card in mini-PRMD

5.3.3 Initial Digital Prototype

Outside the context of semi-formal design meetings, I created a first digital prototype, embodying a possible resolution to the impasse described previously. This initial digital prototype is based on a split screen setup, telling two biographical stories. Two human bodies are tracked as they move in front of a wall projection. Accordingly, the interaction space is divided into a left half and a right half. Each one of those halves is subdivided into equidistant tiles of uniform shape and size (fig. 5.7).

A biographical story is represented as a sequence of cards, adhering to a uniform structure (figs. 5.5, 5.6). Every card contains a description, a year, and the protagonist's name.

System operation bases itself on coupling body-projection distances with the cards shown. The distance of each body to the sensor is computed. Depending on current distance, the corresponding card is picked and shown. A special joint-card describing a juncture of both biographies is hidden at the end of the narrative: If both users stand on their respective final cards, this joint-card is displayed across the full area of the projection.

In response to concerns regarding accurate representation of time based-data, the selection mechanisms for cards was eventually changed: A *shared timeline* is introduced, giving rise to a mapping between sensor distances and historic dates. Whenever a user reaches a date for which a card is available, the corresponding card is selected and shown.

Development Process Development proceeded from artefact creation to practices of interpretation, evaluation, and use, in accordance with the adopted practice-based methodology. Creation of the initial digital prototype occurred outside of semi-formal development meetings. It was written during a train ride in Germany - seemingly with no goal other than passing the time. Since the initial technical framework of LOOPHOLE already was in place, only the interactive application UI and database components had to be developed within this iteration.

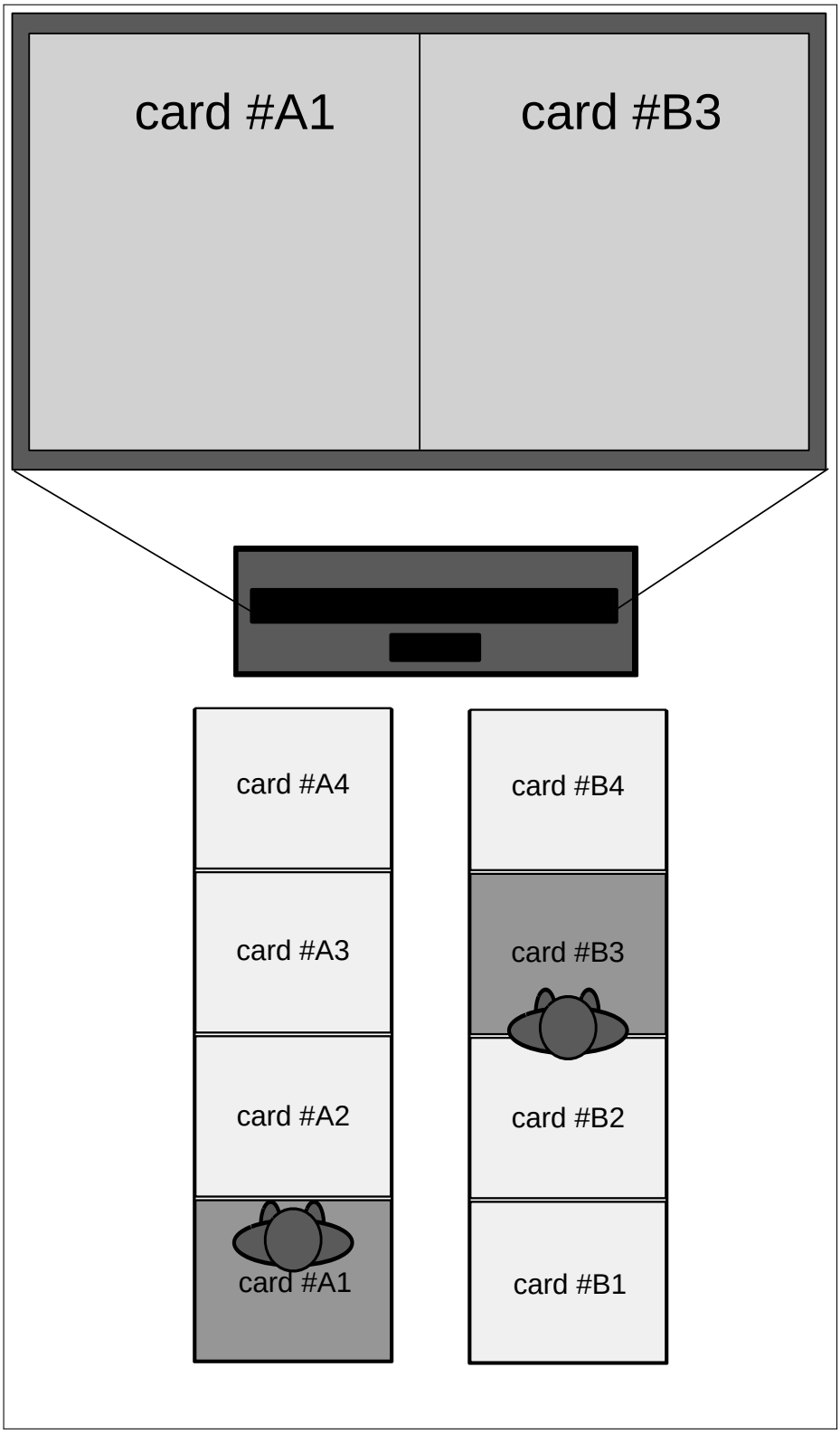


Figure 5.7: PRMD – Initial Equidistant Layout

5.3.4 Discussion / Reconstruction

The iteration proved to be an accentuation of the *narrative* dimension, already present within previous prototypes. The focus lay on experiencing narratives in a way that encourages discussion and contestation. The creation of PRMD thus marked a sharp departure from data centric designs inspired by C E L L.

Consequently, the project departed from an early focus on providing visualisation for historical data and data mined from the social web. Instead, the aspect of providing narration as a means of creating a stage for users gained in importance. Within the context of this iteration, the goals of generating narrative and providing accurate visualisation *collide* for the first time. Initially, prototypes were thought to aggregate information from databases automatically. These were believed to provide a visualisation of historical data. Consequently, two differing perspectives on the status of the artefact emerge: My perspective is that of providing a compelling narrative for users, regardless of any connection to data. Pfeiffer maintains the status of the artefact as 'conveying' data-based content to users. Her suggestions thus often centred on providing a more informative view of the data-space to users.

The ensuing dissensus could be framed and understood employing the categories provided by the adopted theoretical and methodological framing (see chapter 2) and thus be rendered productive within the situational parameters of the prototyping process. The conflict was subsequently reconstructed as response to the underlying challenge of striking an adequate balance between complexity and complication: Is the artefact to be construed as a narrative device, as part of a complex practice, or as complicated apparatus, exposing data in exact, repeatable manner? The PRMD-artefact constructed by me in the discussed iteration leaned heavily towards provision of curated narratives.

5.4 Design Meeting

The prototype was presented within a semi-formal design meeting, employing the method of studio critique. Due to insufficient space within the meeting room, interactive operation could not be facilitated within available space and thus had to be simulated: User positions were not tracked using a Kinect sensor. Rather, a driver component was written on-the-fly which provided the sensor layer with data of two users moving back and forth in front of the display. Movements were simulated to occur with constant speeds, while speeds differed between both simulated users. Overall feedback was positive; the general idea was perceived as novel and engaging. Participants voiced concern regarding the question, whether users would be able to discover the 'hidden' joint-event in time.

5.5 Laboratory Study

The interactive prototype was installed within one of the Visual Computing Group's computer labs. Participants were recruited from students and research assistants. Interactions were observed during prototype operation. Antecedent to prototype utilisation, experiences were discussed with participants.

Expectations

Following positive feedback during studio critique, I expected users to encounter a positive and engaging experience. Engagement with the subject matter would lead to discussions regarding social and political significance of content presented.

5.5.1 Results

Observation The event switching mechanism proved confusing to users. They did not seem to expect cards to change, and the mechanism underlying card switching did not seem comprehensible to them. Especially when they were standing next

to each other, keeping uniform distance to the sensor, being presented with two cards bearing different years proved to be counterintuitive (fig. 5.9). The fact that event switching did not happen synchronously seemed to distract from the intended effect of creating a joint narrative for users. Due to the succession of mild disorientations, users possibly focused more on orienting themselves within their individual narrative than on connection with fellow users. Encountering the joint-event led to further confusion: It was not construed as triggered by a joint action. Furthermore, users did not report their experience as being part of a narration. Rather, the prevalent feeling seemed to be one of being presented with bits of information, seemingly at random.

Discussion Encountered patterns of confusion came as a surprise. This unanticipated phenomenon dominated anticipated practices of discussion and joint experience, which hence could not be observed. It has to be noted that experiencing the joint-event as confusing does not pose a problem in itself. The problem lay in the fact, that ensuing confusion did not trigger conversation connected to presented content. Instead, it highlighted the material structure of the artefact, rendering it present-at-hand, thus grabbing user's attention. Hence, the problem lay in the fact that users were not confused *together*, and thus not irritated in a productive manner. Rather, they became isolated in their confusion, only able to connect after they had left the experiential nexus provided by the installation. The installation consequently did not provide a narrative arc, instead shooting off information in the direction of users who do not expect it. They subsequently are overwhelmed by the task of making sense of individual, seemingly unconnected information displays.

5.6 Iteration #2

In order to reinforce the mental model of 'moving through' time, bodily movement was coupled to the position of a text box on

the projection (fig. 5.10). The absence of a narrative arc was addressed by hiding a subset of the previously displayed information, thereby creating a moment of expectation: In order to achieve this effect, the structure of cards was changed (fig. 5.11).

The aspect of coupling between physical and digital identities remained unaddressed during the first iteration of prototyping. In the second iteration, it was reaccentuated through inclusion of hashtags in system output (fig. 5.12).

Joint-event presentation was changed fundamentally. The 'confusing' effect of temporarily dissolving the split-screen layout was ameliorated by employing a hybrid presentation strategy. A joint-event was presented by abandoning the split-layout on the level of event-textboxes, while retaining it on the level of images (fig. 5.13). Additionally, persona names were displayed in boxes above the joint-box.

The adopted sliding-timeline presentation strategy introduced a set of new design problems. It was now possible for users to leave the area within the timeline that overlaps with their persona's life span. If they went back prior to the beginning of a persona's life story, they would enter an *unborn state*. The mode of presentation for this state was initially undefined and a suitable presentation strategy had to be found. Likewise, it was possible for a single user to enter the zone containing the joint event. As the joint event itself would only be shown when both users are in this *critical zone*, the resulting configuration, dubbed *rendezvous-configuration*, had to be handled.

The unborn state was handled by hiding the sliding box of the corresponding user completely. The rendezvous-configuration was handled by presenting a series of question marks within the textbox of the 'lonesome' user within the critical zone.

Considerable prototyping efforts were spent on the system's physical layout, an aspect previously absent from the team's considerations. Floor layout emerged as a new concern, which had not previously received significant attention.

Explicit instructions in the form of text or a user manual were regarded as detracting from the immersive quality of the piece. Likewise, sign-based instructions seemed ambiguous and potentially obtrusive.

With recourse to the adopted theoretical framing of actor-network-theory, the functions of these material elements were analysed and contextualised as processes of *delegation*: While testing in design meetings and lab situations an instructor was always present, able to immediately direct and shape users' expectations. In the absence of instructors, the instruction 'please walk towards the projection in pairs of two, approximating two straight lines' had to be delegated to a non-human element (see Latour's discussion of delegation[8]).

[8] Bruno Latour: Where are the missing masses? (2008), 154ff.

A hopscotch-like layout was prototyped, mirroring story structure on the floor. However, this course of action would complicate the setup process: Either every change regarding sensor behaviour and story structure had to be reflected within the floor layout or an automatic fitting mechanism would have to be coded. This fitting mechanism would adjust sensors and timescales in a way best suited to constraints imposed by floor layout and story structure. A further alternative consists in adding a floor projection through addition of a ceiling mounted projector. However, during prototyping sessions, labels on the floor were perceived to be distracting, as users had to alternate their gazes between floor, projection and fellow users. Furthermore, the mechanism would add further levels of complication to the artefact. Due to these considerations, implementation of the approach was postponed.

In the end, two red carpets were chosen in order to mark interactive zones (fig. 5.14). A 47 inch LCD TV was employed as display device. The Kinect sensor was placed directly underneath the display, in order for it to remain inconspicuous. Both display and sensor were placed on a table covered by a black cloth.

In order to be able to witness discussion processes, an exhibition stand was added to the installation layout prior to the field

study (fig. 5.15). It would allow team members to take part in discussions antecedent to artefact usage.

5.6.1 Field Study

The prototype was deployed in the context of a media fair hosted by Chemnitz University (“Chemnitzer Medientage”). For the purposes of the presentation, one pair of hand-crafted narratives was chosen. Evaluation of user generated content was not part of the study at this point.

Expectations Relative simplicity of the chosen presentation strategy was expected to detract from user experience. The effect was expected to be exacerbated in the setting of a media fair, since users were exhibiting a high degree of familiarity with contemporary media products. Likewise, a portion of users were expected to be bored or disenchanted after engaging with the artefact. Since visually spectacular effects had consciously been avoided, a portion of users were expected to dismiss the artefact on the aforementioned grounds. Special attention was given to the question whether the device indeed produced dramatic arcs concordant with the intention of providing narrative.. Likewise, engendered discussion processes were in focus: Whether or not users would engage in discussion on the subject matter and what form and structure this discussion would assume, was framed as important open question. The team expected short interaction times of about one to two minutes.

During the presentation, one to two team members were present near the installation at any time. Observations were protocolled in the form of text notes. Additionally, system users were interviewed antecedent to their use of the system, employing an open ended interview strategy.

5.6.2 Results

In total, approximately 20 interactions were documented. Visitors not actively engaging with the artefact were careful to avoid the interaction space. Virtually no visitors crossed the carpets

without trying to engage with the installation. Visitors frequently showed pronounced signs of hesitation before stepping on the carpets. When entering the interactive zone, users initially appeared anxious and self-conscious. Frequently, small groups of bystanders gathered within safe distance of the artefact as soon as interaction processes were in progress.

Anticipated reactions of rejection did not occur. In general, users' feedback was positive. Since non-users were not included in the interview process, however, no general assessment of system attractiveness is feasible. It remains possible only users who would subsequently enjoy offered experiences were attracted by the system.

The intensity of liminal and performative aspects caused by the perceived boundary between user-performers and bystander-audience exceeded expectations. Users were anxious as to whether they used the setup 'correctly'. They frequently glanced over to the team, sometimes asking "Are we doing this right?". Users moved slower and more cautiously than expected, sometimes tiptoeing through the interaction space. They frequently glanced over to their interaction partners. They commented on each other's status. They would sometimes try to direct their partner to a location they felt preferable. Multiple times, they would coordinate in order to walk as closely together as possible.

Critical voices, however, were not entirely absent from user remarks. Criticism was levelled at the artefact "not explicating how it could be marketed or sold". Likewise, it was perceived as being too "modest", not "explaining to users why they should use it in the first place".

In one instance, the unborn configuration triggered the remark "Look, I am older than you are." Other users encountering the unborn state initially voiced concern to have made a mistake, as they were not presented with a textbox as their interaction partner had been.

A high number of users inquired about the internals of system operation. Frequently, they suspected the carpets to con-

tain or conceal pressure sensing equipment. After having 'completed' the narrative, they would join the observers and exchange theories regarding placement and configuration of hidden hardware elements. In contrast, the Kinect sensor was infrequently spotted. In most instances, it seemed to be perceived as part of the display.

Entering the joint-event was met with expressions of surprise. Mode of presentation of the joint-event involving a translucent red textbox initially seemed to be causing discomfort. As soon as the red message appeared, users showed signs of worry. As a result, the colour-scheme of the joint-event was changed multiple times during system operation. Likewise, after having successfully explored joint events, users seemed to be unsure if their interactive experience was indeed complete. In multiple cases, they seemed inclined to stay within the interactive zone, only reluctantly joining team members located at the exhibition stand.

Discussion

PRMD successfully acted in the capacity of a material frame, causing visitors to become carriers of practices of discussion, performance, and joint exploration of biographical narrative.

After interacting with the artefact, users frequently engaged in discussions focused on the subject matter. Thus, analysis of made observations initially found itself confronted with a problem: The artefact had been more successful than anticipated. Consequently, the hypothesised patterns of failure and rejection could not be analysed. As a consequence, developed interpretational framings were invalidated and new ones had to be found.

The extent of the performative dimension was greater than anticipated. Possibly, the emphasis on this performative dimension was brought about through variations introduced on the level of the material setup. Especially, the effect of red carpets in order to modulate patterns of movement was more complex than anticipated. Red carpets did not only convey the injunc-

tion to walk back and forth in front of the display. They simultaneously imposed a novel situational framing. Associations attached to the symbolism of the “red-carpet” reinforced users’ construal of their roles as that of performers.

A surprisingly strong performative element could be observed, causing an effect of ephemeral identification with presented personae. In result, there were traces of an ’I-making-practice’ among the artefact’s effects. It created ephemeral subjectivities, which later on become available as objects for the practices of reflection, discussion and self-distancing.

The exhibition stand can be reconstructed as an element negotiating non-use of the installation proper. As such it operates as an *antiprogram* in the sense of Latour (see 9.1.3). Both the concern with performative phenomena and the concern with organisation of non-use emerged as a result of artefacts created within the iteration. Both phenomena subsequently informed further amendment of the theoretical-methodological apparatus.

The engendered practice of “giving a performance” was readily adopted. However, its structure did not supply a clear endpoint for the interaction. Visitors were given the role of performers, while at the same time, they seemed unable to determine when their performance had come to an end. Red carpets had changed the framing of the situation, likening it to experiences in a theatre. At the same time, there was no counterpart to the “curtain falling” experience, forcing performers to negotiate this particular antiprogram (see 5.6.2) themselves.

Within this context, the added exhibition stand assumed a more comprehensive role within the negotiation of interaction patterns than anticipated. It acted in the capacity of an antiprogram, drawing users away from further interaction with the artefact. It thus was instrumental in making visitors carriers of the practice of discussion and in alleviating the problem of the open ended performance described previously.

5.7 Iteration #3 – Digital Identities and Conference Demo

The creation of an on-site discussion process had already succeeded within the context of the media fair. However, the question whether observed interaction patterns would remain stable over varying situations still remained open. Furthermore, the concerns of user-generated content and digital identities had not yet been reflected in system design. The aspect of performativity, however, extends into the sphere of digital practices of identity construction unfolding within the space of social media. Accordingly, new modes of integration with social media were implemented, allowing for user generated content to be added by editing a Tumblr blog.

Demonstration The modified installation was shown at the German "Mensch & Computer 2014" conference, as part of its demo session.[9] Material setup and projection design were similar to that of the preceding iteration. However, only one team member was present at the installation. Moreover, the demonstration area was not able to accomodate the exhibition stand layout present within the media fair due to size constraints. An additional team member was online throughout the presentation process, remaining available to remotely aid with managing Tumblr based content.

[9] Michael Heidt et al.: Prmd (2014).

Discussion In general, users reacted positively to the prospect of supplying their own content. Multiple times they pointed to the fact, that their existing content could easily be adapted to fit the structure of PRMD. At the same time, however, no user engaged with the Tumblr backend, actually supplying user generated content.

PRMD seemed to successfully frame movement and interaction patterns, as was observed in the preceding iteration. The structure of mapping between time and space was highlighted by users as a positive idea. The installation was described as evoking the desire to stroll, to act as "flaneur" within history.

5.8 Conclusion

PRMD successfully acts as material frame for the complex practice of jointly performing biographical narrative. The respective prototyping process was driven by a tension between accurate representation of complicated historical data and the desire to deliver a compelling complex narrative. The employed theoretical-methodological apparatus proved adequate to sustain a reflective prototyping process. It intertwined theory construction with effective construction and contextualisation of prototypes. Within this process, construals calling attention to performative aspects were crucial while reconstructing engendered practices. The turn towards practice was thus validated, especially in relationship to the first dimension of practice identified earlier (see 2.3). Visitor acceptance did not seem to be impacted negatively by artefacts exhibiting less complicated structure. On the contrary, acceptance of comparatively simple artefacts occasionally surpassed that of their more complicated counterparts.

On a methodological level, the dimension of non-use was of particular importance regarding processes of shaping and modulating practice. In particular, it was instrumental to turn users into carriers of the practice of discussion. With recourse to the adopted Latourian frame, creation of these practices can be construed as resulting from the tasks of programming and anti-programming. This has profound implications for the role of designers: Their responsibility thus encompasses materially framing patterns of technology use as well as non-use, of providing incentives to engage with constructed devices as well as providing a way to disengage from interactive systems and enter into practices of debate and discussion.

Methodological implications and further developed methodological support are discussed in sections 9.1.2 and 9.1.3.

5.9 Future Work

Within detailed project contexts, PRMD was evaluated in contexts where personas are expected to be "likeable". Other modes of presentation might be appropriate for "playing the villain" within a historical scenario. Additionally, the online-community aspect of the system proved notoriously hard to evaluate. Consequently, at this time few empirically saturated statements are possible concerning this level of operation.

So far PRMD was used to narrate the story of human individuals. It could be used to narrate the story of artefacts, thus prompting identification with non-human actors.

Figure 5.8: PRMD – Screen Layout of Initial Digital Prototype

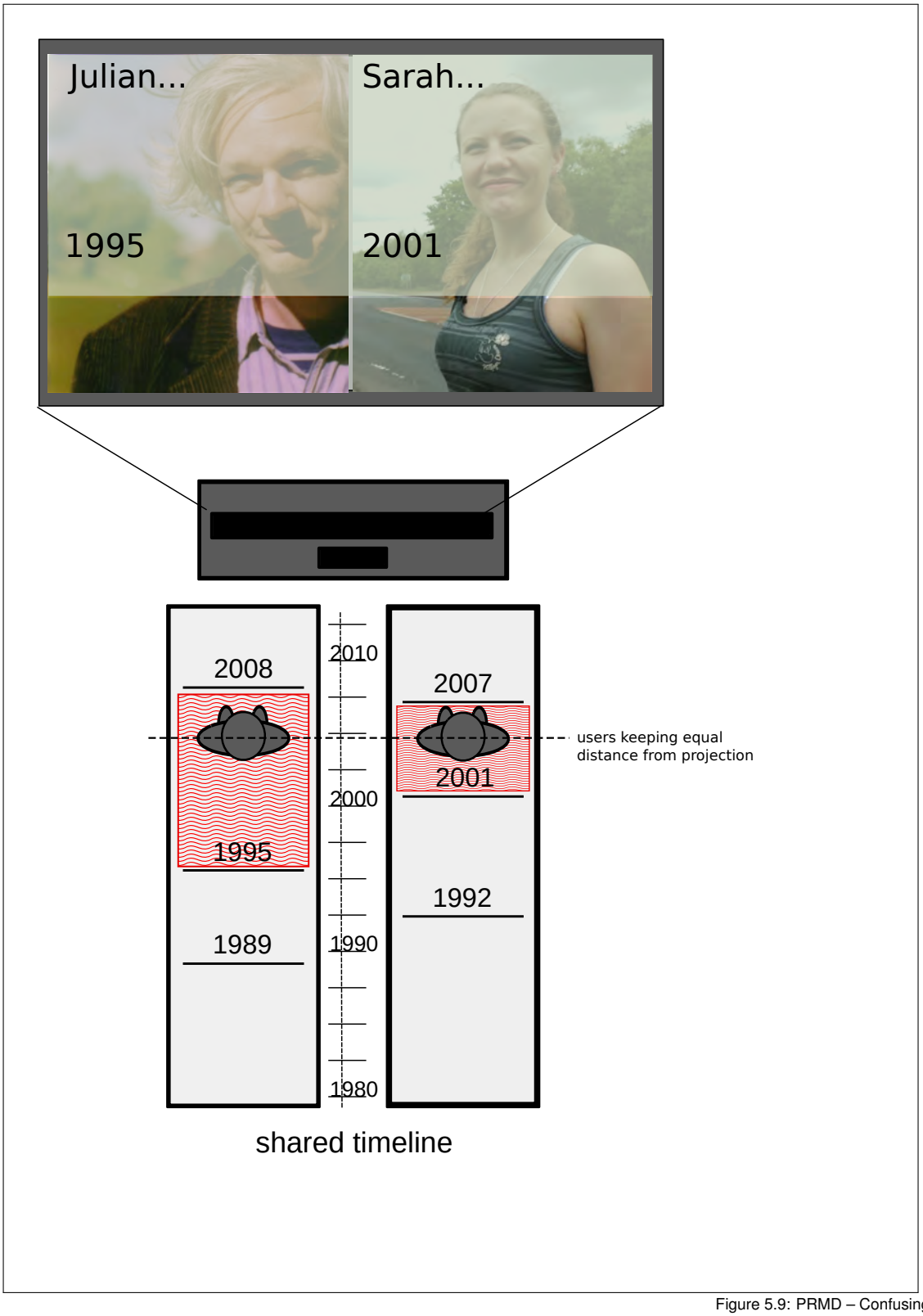


Figure 5.9: PRMD – Confusing Effect of Early Card Switching Mechanism

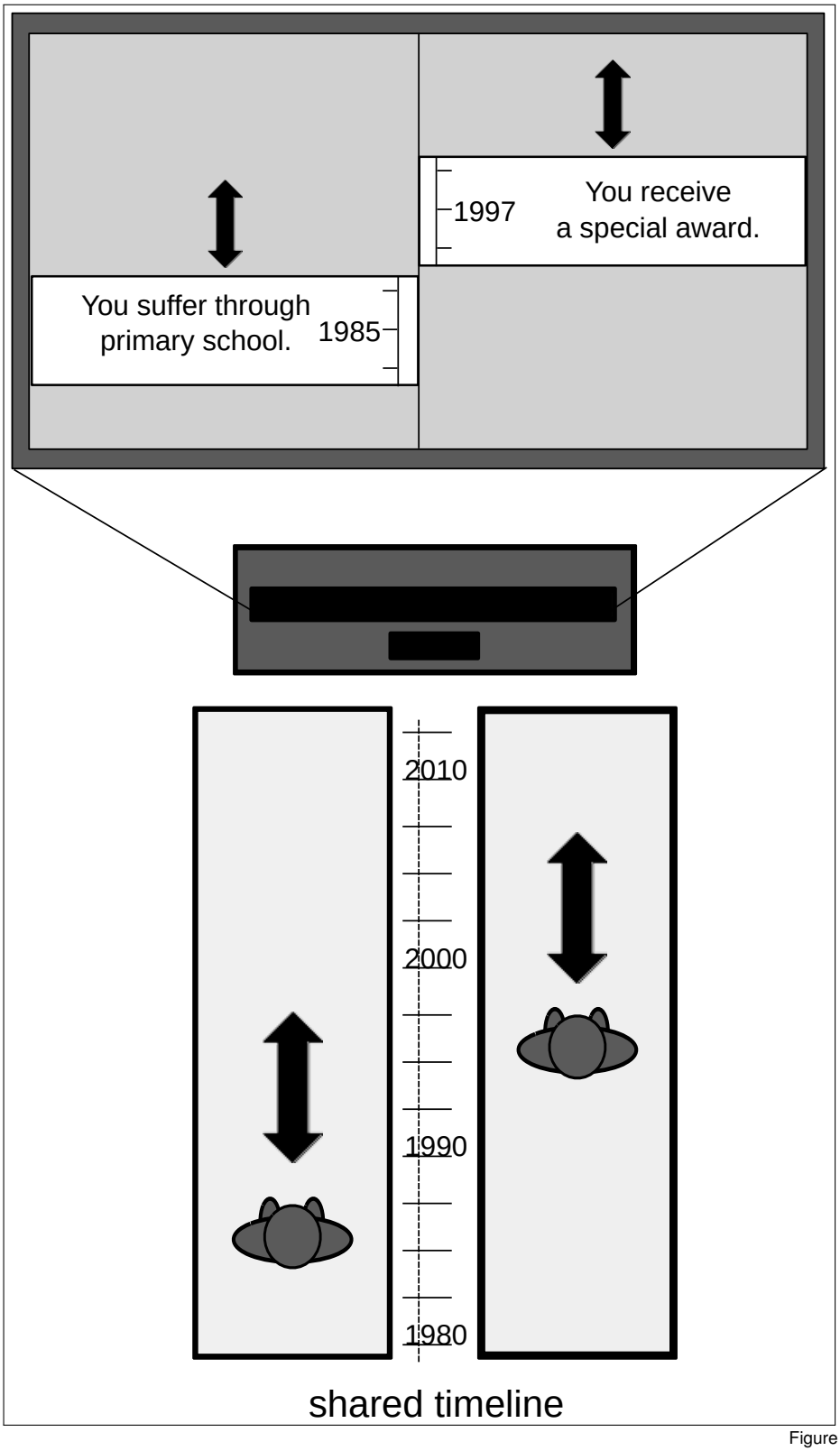


Figure 5.10: PRMD – Sliding Timeline Concept

Figure 5.11: PRMD – Updated mode of event presentation

Figure 5.12: PRMD – Textbox Containing Hashtags

Figure 5.13: PRMD – Updated Mode of Joint-Event Presentation

Figure 5.14: PRMD – Material Setup during Chemnitz Media Fair Field Study

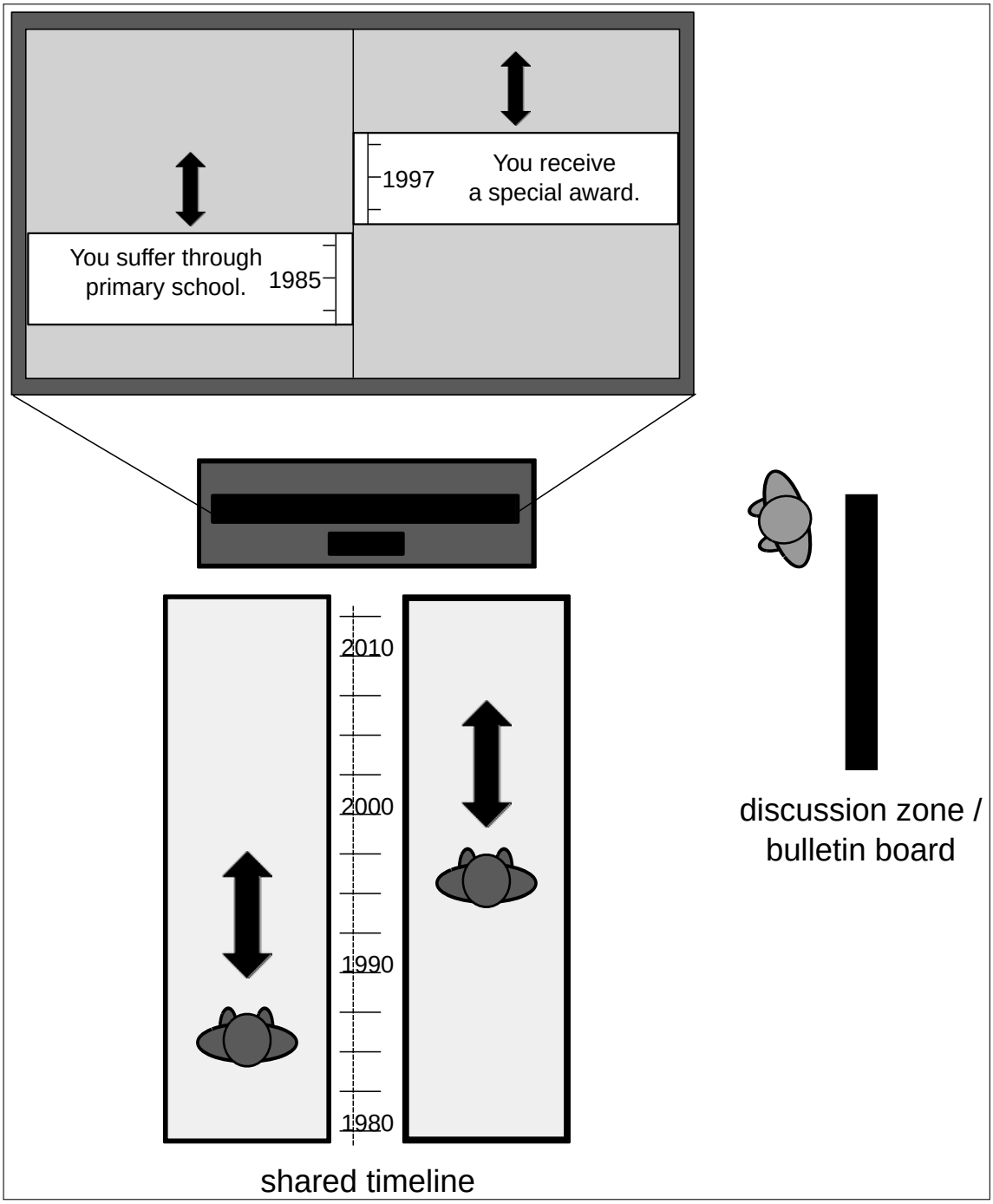


Figure 5.15: PRMD – Installation Layout Including Exhibition Stand

6
ASSMBLG – Tangible Tabletop

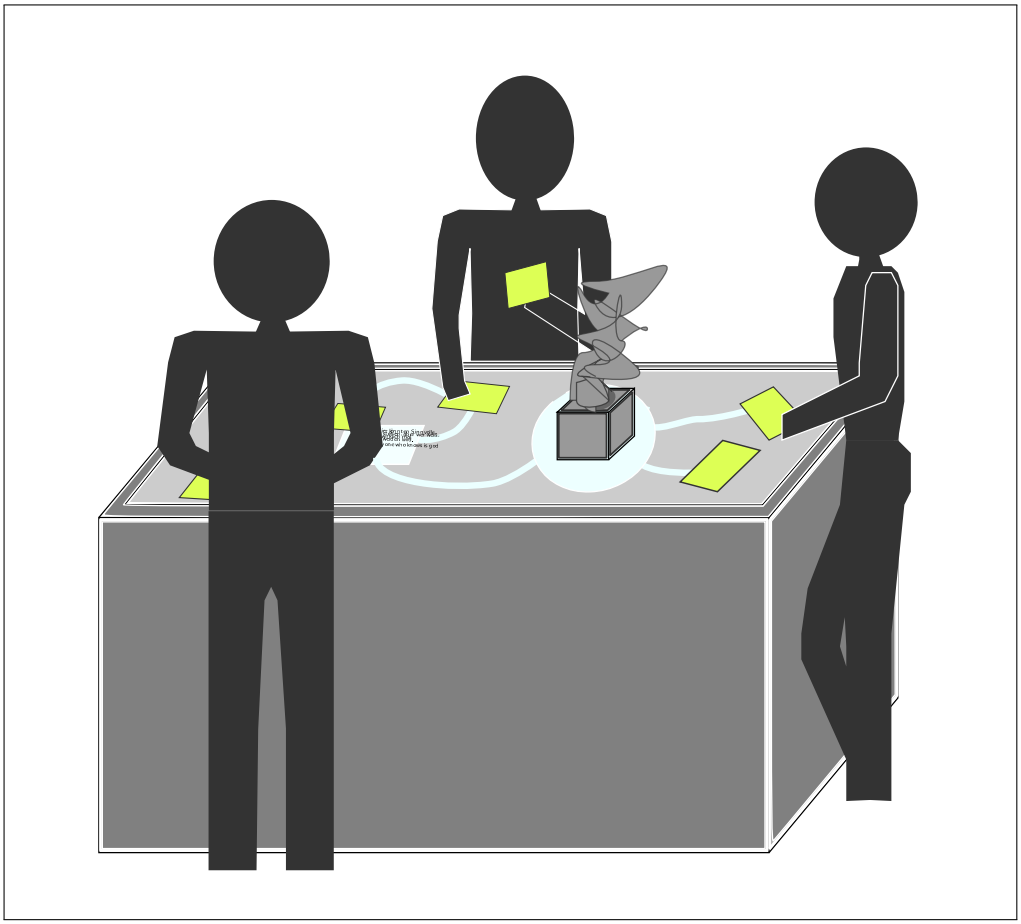


Figure 6.1: ASSMBLG – Concept Drawing

THE SKIN IS A VARIETY OF CONTINGENCY: IN IT, THROUGH IT, WITH IT, THE WORLD AND MY BODY TOUCH EACH OTHER, THE FEELING AND THE FELT, IT DEFINES THEIR COMMON EDGE. CONTINGENCY MEANS COMMON TANGENCY: IN IT THE WORLD AND THE BODY INTERSECT AND CARESS EACH OTHER.

– MICHEL SERRES

6.1 Introduction

The ASSMBLG prototype explores the status of materiality and sensorial mediation within practices of cultural education. It is constructed as a tangible interface,[1,2] thus highlighting the necessity of sensorially rich modes of engagement with tangible cultural heritage. Arranged in a tabletop setup, it was designed for interaction with exhibits while facilitating discussion among visitors. The prototyping process unfolds in reaction to a concern with the question of *materiality*, which in the course of the project came to encompass non-physical material in the form of code and software artefacts.

Regarding the structure of the thesis as a whole, it relates to the second dimension of practice. It does so through a concern with the status of *materiality* both of artefacts produced during prototyping and those belonging to tangible cultural heritage. The development project is an instance where different epistemological commitments could successfully be integrated into a form making process. It complements the methodical toolkit employed during other studies with qualitative analysis of video data conducted in the course of a user-study. The contextualisation of ASSMBLG within the research process underscores the methodology's ability to operate within a dialogical capacity.

[1] George W. Fitzmaurice/Hiroshi Ishii/William A. S. Buxton: Bricks (1995).

[2] Hiroshi Ishii/Brygg Ullmer: Tangible Bits (1997).

6.2 Motivation

Development efforts were initiated through a concern with the material qualities of the museum experience:

Frequently, impressive collections and comprehensive informational offerings appeared to go hand in hand with a dearth of sensorially rich experiences. Indeed, within many observed traditional museum environments, experiencing the material qualities of exhibits appeared outright impossible.

Exhibits are kept behind glass or other barriers while visitors are prohibited from experiencing them by tactile means. Objects are removed from users' touch, smell and taste. Likewise, supporting interactive systems are neatly separated from the historical materials they refer to. When users press plastic keys, slide their fingers across aluminosilicate glass, or interact via the touchless interface provided by optical sensors, they are not sensorially interfacing with actual historical material. Instead, the familiarity of computer interfaces glosses over the sensory diversity of cultural heritage. Furthermore, information is mainly communicated through labels and texts neatly separated from the exhibits themselves. Considerable efforts of visitors are devoted to dealing with these additional materials, drawing attention away from immediate sensory engagement with exhibits.

Consequently, early discussions centred on possibilities of sensorial immediacy whose facilitation was desired by the project team. The potential of constituting this immediacy seemed to be missed in many existing interactive exhibits.

In order to deal with these perceived limitations, the ASSMBLG project tries to reconfigure described interactional dynamics. The exhibit itself is the interface. Exhibits serve as tangibles, to be directly touched and manipulated by visitors. Additional information is displayed in close proximity to the exhibit itself, in response to interactions with tangible UI elements. Thereby, exhibits' materiality is foregrounded, while the system still provides supporting information and helpful explanations.

6.3 Development Context

The ASSMBLG project was conducted in the context of the crossWorlds research training group at Chemnitz University of Technology. Unlike other projects discussed, digital components of ASSMBLG were not built by myself. The main developer within the project is Linda Pfeiffer, while I acted in the capacity of academic collaborator, academic internship supervisor, and master thesis supervisor.

The respective thesis was embedded into an overarching research project conducted by myself and situated at the crossWorlds group. Despite differences in academic status, disparate research interests, and differing roles and responsibilities, researchers within the project engaged on an equal footing as far as possible. This mode of equitable discussion allowed for Pfeiffer and myself to frame the project in dissimilar terms: While it acts as an instance of a hybrid project for me, she did not intend it specifically to accommodate practice-based elements. Instead, she conceptualised it as a systems development task, aimed at the goal of furthering cultural experiences through production of digital technology.[3] Both interpretorial frames, however, can be integrated. As discussed previously (see 3.2.2), a hybrid-project combines characteristics of traditional technology production projects with the concerns inhering within practice-based research inquiries. Consequently, it was possible for me to align Pfeiffer's interests with the goal-oriented side of an overarching project. This integrative project embraces solution oriented thinking while encompassing concerns of cultural relevance entailed by incorporation of elements of practice-based research.

Congruent with the methodology described in chapter 8, a shared theory was appropriated by virtue of individual readings. This conceptual basis was provided through a joint reception of the theory of Embodied Interaction, especially Dourish's monograph *Where the Action Is: The Foundations of Embodied Interaction*.[4] My reading situated Embodied Interaction within the philosophical project of phenomenology, as well as within

[3] Linda Pfeiffer: Entwicklung und Evaluation von Interaktiven Systemen zur Unterstützung des Kulturellen und Sozialen Erlebens im Musealen Kontext (2014).

[4] Paul Dourish: Where the Action Is: The Foundations of Embodied Interaction (2004).

the tradition of critical technical practice as formulated by Agre.[5] Pfeiffer (to me) seemed to appropriate Embodied Interaction mainly as a framework providing directions for the construction of digital artefacts. She often pointed to shortcomings and omissions within the framework in relationship to design (in a manner sometimes not entirely dissimilar to the way Dourish does himself).[6] While we are both philosophically interested, the status of philosophical theory seemed to be construed differently: As a theory that might prove helpful or unhelpful, or as an intellectual enterprise, an end in itself furthered or hindered by a process of material argumentation.This difference in perspective can again be related to the distinction between goal based and practice-based modes of conducting systems development. Readings of the theory were constantly updated in a process of mutual discussion on both our parts.

[5] Philip Agre: Toward a critical technical practice (1997).

[6] Paul Dourish: Epilogue: Where the Action Was, Wasn't, Should Have Been, and Might Yet Be (2013).

6.4 Paper Prototype – Iteration #1

Following literature survey and discussions within the network of researchers, tangible user interfaces and tabletop setups were chosen as candidates for practice-based inquiry. The design decision in favour of a tangible interface resulted directly from the discussed focus on materiality. Initial discussions had focused on the role of materiality within interactive systems. During initial prototyping sessions the project team noted how the crucial sources of materiality were absent from created systems: the material qualities of the exhibits themselves.

Table-based setups were chosen in order to facilitate a communicative setting among users. To gather at a table was identified as a potentially communicative setting, resembling situations of familiar daily life.[7] At this point of the development process, the exact strategy for setting the stage for interactive exhibits had yet to be determined.

[7] Tom Geller: Interactive Tabletop Exhibits in Museums and Galleries (2006).

Following the focus on tangibility, an interaction concept was developed that situates the exhibit itself in the centre of a system of tangible elements. The system was developed as a series of paper prototypes, to be situated within the discussed

prototype ecology (see chapter 4). Multiple prototypes were developed; one candidate was subsequently agreed on as candidate for further discussion and development (see figure 6.2).

All interaction between user and the system is facilitated through manipulation of tangibles. The basic setup is that of a table on which tangibles are situated. The exhibits themselves are present within the setup as tangible objects. Exhibits reside on a side table and can be placed on the tangible table as users see fit.

On being placed on the table surface, exhibits are surrounded with a circularly GUI element, containing basic information about the object, minimally its name. As soon as multiple exhibits are placed on the table, links between individual circularly elements are rendered as well. These links highlight thematic connections, similarities and differences between present objects. Multiple links between objects are possible: As an example, if two objects exhibit similarities regarding material as well as regarding function, both connections are drawn on the surface.

Stamps are used as tangible metaphors for interaction with information presenting UI elements within the interface. Physical, static labels are attached to each stamp, indicating its function. Examples for labels used are “Historical Context”, “Context of Use”, “Context of Production”, etc. Stamps can be applied both to the circular information clouds and to links between objects. Stamping a site on the table surface causes an information window to appear. As an example, stamping the information cloud attached to tea leaves with a “History” stamp will cause an information window to appear, narrating part of the history of tea consumption.

Stamps were chosen both for their interactional meaning of “producing something lasting” as well as for potential communicative incentives. The number of stamps present is consciously limited to one stamp per type. Consequently, users have to pass stamps to each other, or can ask others

for stamps they need. The intention is to foster a familiar and homely atmosphere facilitated by gathering at a table, in analogy to passing food at a kitchen table during dinner.

A sponge acts as tangible for erasing stamped GUI elements. It can be applied to information windows previously introduced via stamps, prompting windows to disappear.

6.4.1 Interpretation / Discussion

The prototype reconfigured the relationship between user and exhibit while in turn triggering reflections on the role of materiality within the project team. The prototype transforms the exhibit from an object removed from the grasp of a passively perceiving visitor, to a concrete tangible element within the exploratory practice of an active user.

Initial discussions had conceived of materiality as something that is opposed to the digital: A material object is a tangible, physical, non-digital thing. This way of dealing with materiality made theorising the connection between the digital and the material impossible as it obscured its relationship. Consequently, the division material / digital itself had to be questioned.

The setup thus was not seen as a novel way of relating the material and the immaterial. Instead, what was brought into focus was the method of joining digital materiality and tangible materiality. Both offer ways of installing constraints, thus constituting *material frames* shaping practice. In the developed scenario, materiality of stamps and digital materiality underlying display logic work in tandem to further a certain set of communicative practices: Limited availability of stamps in conjunction with coupling of stamp interaction and information windows encourages users to ask each other for desired stamps.

A difference in theoretical framing surfaced between Pfeiffer and myself at this point. While she chose to remain within the framing of Embodied Interaction, complementing Dourish's approach through Klemmer's,[8] I argued in favour of the comprehensions facilitated by practice theory. My arguments focused on the more comprehensive perspectives facilitated by

[8] Scott R. Klemmer/Björn Hartmann/Leila Takayama: How Bodies Matter (2006).

material-semiotic assemblage theory and its ability to integrate and relate concepts that otherwise exist in a form of uneasy isolation.

The joint point of reference constituted by Embodied Interaction, however, continued to serve as useful basis for discussions within the project, providing an adequate shared vocabulary and stimulating points of contention.

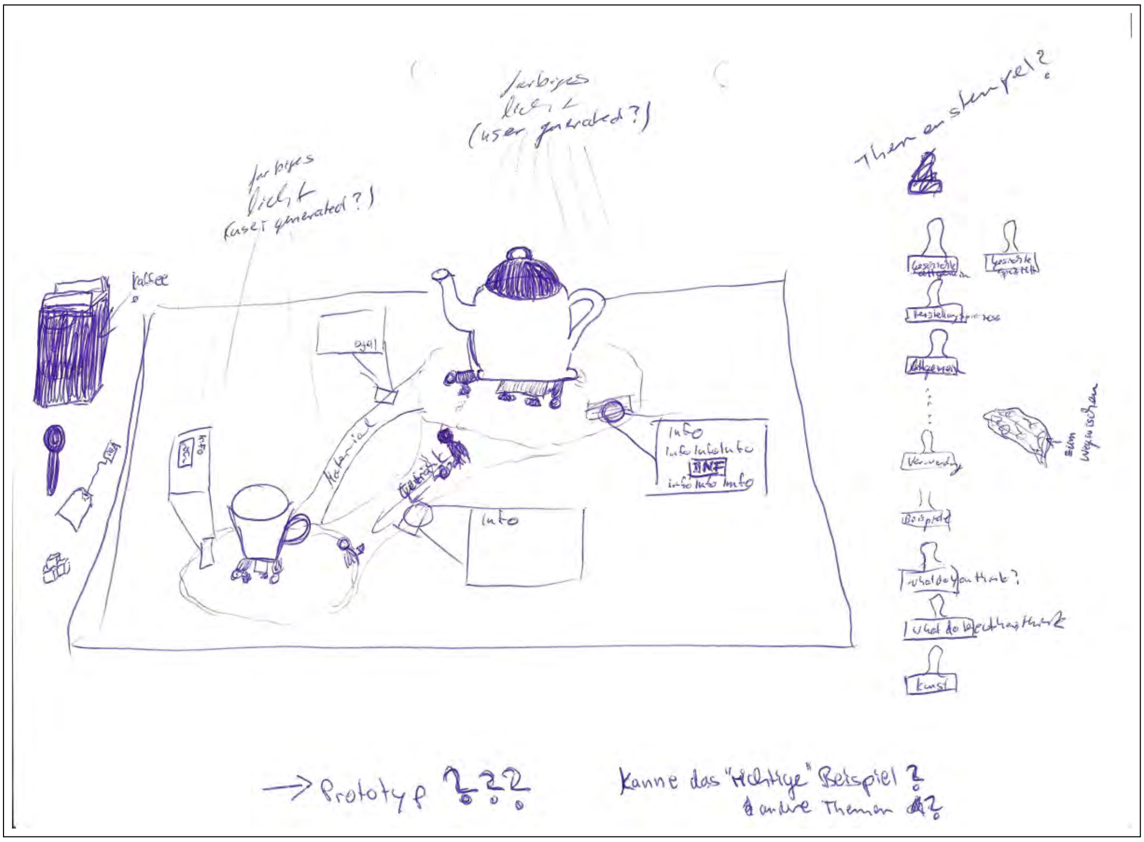


Figure 6.2: ASSMBLG – Teapot Prototype – Concept Drawing

6.5 Observational Study – DDR Museum

A subsequent survey of existing systems pointed to a tabletop setup installed in a museum of Eastern German history[9] (DDR/GDR museum). The system in question featured a selection of objects supposed to evoke eastern German history: a small bust of Lenin, a GDR-pennant, a stapler, an ashtray, a stamp, a compass, a little book, a lock, a small block of wood.

[9] http://www.ddr-museum.de/en

Within a blend of multitouch and tangible interactions, users are encouraged to place objects on the table surface. The information display can subsequently be modified by virtue of multitouch gestures.

Despite some perceived inconsistencies regarding thematic styling and tangible selection, GDR museum's setup demonstrated substantial similarity to developed prototypes. This provided an opportunity to study some of the hypothesised effects firsthand. On the basis of a jointly developed catalogue of guiding questions, Pfeiffer conducted a preliminary ethnography within the Berlin DDR Museum. Data collection consisted of two sessions of participant observation, one conducted covert and one overt.

Based on discussion and literature survey, we expected users to engage with the exhibit in a spontaneous manner. We further hypothesised to witness a comparably high amount of communication among users gathered around the exhibit.

Preliminary results found tangible elements to be engaging, while the overall interaction concept did not seem to be adequately coherent. Presence of tangible elements by themselves did not facilitate communication among participants. A substantial share of communications seemed to focus on preliminary clarification of technical details concerning the interactive installation. A class of interesting observations concerned the ability to take-away objects from other users. Since informational elements on the screen closed immediately on removal of a tangible object, users occasionally closed windows which others were still reading. This created an unintentional communicative incentive by necessitating an excuse to the disturbed user. The dynamic furthermore created the possibility of teasing others. Within a group of younger users, participants started to distract each other by taking away the other's object, thus preventing them from witnessing displayed information.

6.6 Laboratory Study – Iteration #2

Within joint prototyping efforts, we adopted tangibles as providers of affordances while aiming for a more systematic setup of UI elements. A simple digital prototype was constructed and subsequently evaluated within a qualitative laboratory study.

The underlying scenario is that of a visit to a museum of nutrition. The artefact is set up in order to serve as a single installation within this context. The installation deals with fruits which can be explored regarding nutritional value, conditions of cultivation, patterns of use, as well as biological classification. Artificial fruits are used as exhibits, serving in their double-role as exhibits and manipulable tangibles. Within situations created as part of the study design, users are observed in pairs of two. Digital operation of the installation is rudimentary: The artefact operates by displaying a glowing background behind objects within the space tracked by sensors.

6.6.1 Expectations

We expected users to understand the table's basic setup well enough to interact with the installation as intended. The way the interactional stamping metaphor would be accepted and appropriated was formulated as an open question. Additionally, the situational factor of gathering at a table and passing food is further explored within the study. Expectations regarding interactional dynamics are further complicated by a possible tension between the desired playful mode of exploration and usage of food-like items as tangibles. The parental injunction "do not play with food" could either contribute or detract from the enjoyability of the experience. Users' reaction to engaging with food-like items in a playful manner thus received special attention during the evaluation process.

6.6.2 Material Setup

The display rests horizontally in front of users (fig. 6.3). A ceiling mounted optical sensor tracks tangibles' positions. A small

Figure 6.3: ASSMBLG – Material Setup – Lab Study

Figure 6.4: ASSMBLG – Placement of stamps

area next to the display contains stamps and wiping-cloth. Stamps are placed next to the display on a paper card. The card contains a caption for each stamp, assigning it its respective position via colour-coding (fig. 6.4). Instead of a sponge, a wiping cloth is provided. The wiping-cloth is placed on the card as well.

6.6.3 Procedure

Exhibits are arranged in a random fashion prior to commencing the study. Users are confronted with the prototype within an otherwise barren lab room. The area containing the tabletop installation is video-taped with the participants' knowledge. Artefact functions are initially deactivated and are activated only after participants have entered the room and video recording is started. Participants are provided with a short explanation regarding the intended scenario of use. This is given verbally, no additional pictures or props are employed in order to support imagination of participants. They are told to imagine a joint museum visit and are instructed to explore the prototype together.

6.6.4 Observations & Discussion

Evaluation of data collected in this study was conducted in collaboration with sociologist of technology Andreas Bischof, a fellow doctoral researcher at the crossWorlds group.

Multiple problems regarding the stamping metaphor were uncovered during the study: Participants especially had problems constructing a relationship between stamps and fruit. The choice of nutrition as topic proved to be an unfortunate one. While stamps acted as convincing metaphors in the domains of administration or museum settings in general, using fruit as exhibits while retaining stamps as tangibles proved to be problematic.

Direct tangible-tangible interactions were not investigated during preceding prototyping phases. However, they were

among the kind of interactions a large share of users engaged in without any prior instruction.

The setup did not provide adequate affordances for participants to grasp the intended function of stamps. Trying out stamps on the table surface was not among the behaviours engendered by the artefact. Instead, multiple participants tried to apply stamps to fruit items. A potential remedy could be the addition of a rubber stamp pad, as Pfeiffer suggests.[10]

ASSMBLG acted as a material frame for facilitating playful practices of exploration. Apparently, using tangibles evoking food did not preclude playful interactions as a multitude of instances of play-like behaviour could be observed. One participant went so far as to arrange tangibles in a structure evoking a soccer team's formation.[11]

[10] Linda Pfeiffer: Entwicklung und Evaluation von Interaktiven Systemen zur Unterstützung des Kulturellen und Sozialen Erlebens im Musealen Kontext (2014), p. 53.

[11] Ibid., p. 50.

6.7 ASSMBLG – Discussion and Reflection

Following the described practice-based methodology, the conceptual apparatus was constantly refined in order to account for encountered phenomena. Consequently, the relationship between theoretical framings and observed development and usage practices was continuously renegotiated. Corresponding conceptual developments and trajectories are discussed in this section.

6.7.1 Reflecting Theoretical Framings

Embodied Interaction was employed as theoretical lens for reconstructing both user behaviour, as well as prototyping activities. It thus served as a common point of reference during processes of discussion and making.

As intended, the framework acted in a unifying manner, allowing characteristics of tangible technology as well as social interaction to be discussed within a single conceptual system. However, its somewhat unclear relationship to concrete activities of design and heterogenous theoretical base also pointed to its shortcomings. As Dourish himself notes, the theory is

prone to sketchiness in relationship to design.[12] Its comparably eclectic way of theorising made construction of coherent theoretical artefacts an unnecessarily arduous task. Careful readings of the theory found it to be oscillating between "radically situational" conceptions of social phenomena and those more amenable to the adopted frame of practice theory.

Embodied Interaction was complemented by supporting theories throughout the making process. Materiality was theorised by virtue of writings of Leonardi and others.

[12] Paul Dourish: Epilogue: Where the Action Was, Wasn't, Should Have Been, and Might Yet Be (2013).

6.7.2 Non-Use

The dimension of non-use did not emerge as an explicit goal as it did within the context of PRMD (see 5.6.2). However, it emerged in a tacit manner and was thus given a special status in the context of the interactive exhibit. Since users are interacting with exhibits while interacting with the system, use of the system entails attention given to the exhibit. Attention is not drawn away from exhibits and non-use of the system does not free up users in order to engage with exhibits themselves.

6.7.3 Materiality and Disciplinary Difference

In practice, discussing different approaches towards materiality in itself had a catalytic effect. As is so often the case within interdisciplinary cooperation, explicit debate allowed for unproductive misunderstandings to be averted. As a resulting artefact, the project team created a joint publication,[13] serving as a common point of reference for future discussions. Again, providing a stable artefact in the form of a text allowed for dissensus to be made explicit and thus become productive. While for some project participants "material artefact" apparently meant "an object that can be touched", more nuanced positions regarding the status of respective materials, informed by philosophy and social theory, emerged and could subsequently be framed and discussed in a productive manner.

[13] Michael Heidt et al.: Tangible Disparity – Different Notions of the Material as Catalyst of Interdisciplinary Communication (2014).

As a result, the notion of materiality aided in grasping the specificity of computing practice. The difference between disciplinary practices could be redescribed by adopting the notion of *digital materiality*. Contrasting the way disciplines approached the problematic of the material thus allowed for productive shifts in perspective.

In order to grasp this difference, computing professionals had to educate themselves regarding the structure of their own digital products. By grasping the material nature of computer programs, the relationship between digital product and physical environment became less elusive, more clearly conceptualised. The notion of digital materiality hence served as a conceptual bridge to theories and practices within the social sciences, such as the approach of *sensory ethnography*.[14] Thereby, reflections on the problematic of digital materiality facilitated interdisciplinary communication with cooperating social researchers.

[14] Sarah Pink: Doing Sensory Ethnography (2009).

6.7.4 Materiality and Responsibility

In addition to the implications discussed, the developed conceptual apparatus allows for theorisation of the relationship between questions of materiality and the question of responsibility of design. If we accept that material interfaces condition our sensorial access to the world, we have to become mindful of what kinds of experiences we enable and what kinds we inhibit.

Many computer interfaces restrict sensory experiences, instead confronting users' senses with the ever identical impressions of glass covered touch-displays and plastic buttons. These "sensorial monocultures", however, do not do justice to the structure inhering within sensorial experience. As authors such as Merleau-Ponty point out, there is an inherent multiplicity of perspectives evoked by supposedly "simple" sensory experiences.[15]

[15] Maurice Merleau-Ponty: Eye and Mind (1964).

Indeed, it is possible to attribute wider ethical implications to this dimension of sensorial multiplicity. Read against the backdrop of an inner relationship between aesthetics and ethics,[16]

[16] Astrid Wagner: Kreativität und Freiheit. Kants Konzept der Ästhetischen Einbildungskraft im Spiegel der Freiheitsproblematik (2005).

experiencing multiplicity on the level of the senses can be construed as conceptual and socio-psychological precondition for ideas such as freedom and tolerance. If we were to follow a reading of this kind, installations had to be construed as devices tasked with allowing and fostering sensorial multiplicity and variation – not only for the sake of interactional efficiency, but also due to ethical considerations.

Materiality and Inter-User Interaction

An interesting question emerged in this context by reapplying the theme of "connecting users". Would there be an obligation for facilitating touch among artefact users? Pursuing the idea could entail building on existing work in the field of embodied interaction.[17]

[17] Mads Hobye/Jonas Löwgren: Touching a Stranger: Designing for Engaging Experience in Embodied Interaction (2011).

Arguing with Digital Materials

The updated conceptual apparatus regarding material argumentation also allows for novel ways of expressing the feeling of being overwhelmed by seemingly alien constraints and restrictions imposed by digital systems around us. In these situations, the argument between ourselves as designers and users and the materials we employ seems to be "going the wrong way". In situations where we are overwhelmed by the complication of digital systems, we are losing the argument against the materials we are tasked to master.

Designers as Material

Another distinction had to be rethought during the making process, that between the designer and the materials she employs. As both researchers, Pfeiffer and myself, were not HCI specialists at the beginning of the project, we initially were not equipped with requisite sensibility for dealing with cultural complexity encountered during the design process. Hence, the subsequent process of prototyping was perceived not only as that of reconfiguring material into artefacts but also as one of reconfiguring ourselves.

In effect, the notion of material reshaped during the practice of design had to include designers as well as the non-human materials acting as building blocks of artefacts. While puncturing the distinction between digital and physical things seemed comparably straightforward, thinking a connection between material and designers proved more challenging. A tentative formulation of this relationship could be arrived at with recourse to Berger's neuro-psychologically grounded concept of somatic intuition.[18] This was extended during a collaboration with Berger and myself in order to be intermateable with the adopted practice theoretic focus.[19] The solution, again, lay in adoption of Latourian practice theory, with its equitable treatment of human and non-human elements regarding their capacity for action.

[18] Arne Berger: Prototypen im Interaktionsdesign (2014), 121ff.

[19] Arne Berger/Michael Heidt/Maximilian Eibl: Conduplicated Symmetries (2015).

6.8 Conclusion

The ASSMBLG project synergistically combined design of a tangible UI system with an inquiry into the role of materiality and sensorial experience. To this end, the project comprised a renegotiation and remodulation of the relationship between exhibit and interface. This led to a resharpening of the conceptual apparatus employed by the project team (see fig. 6.5 for a graphical overview of conceptual developments during the project). Adequate interaction patterns and metaphors were proposed. These were evaluated during the course of a lab study.

Thus, apart from creating a sequence of design prototypes, the ASSMBLG project led to a reflection on the status of materiality. Initially conceived as a concept opposed to the digital, it was rethought through integration of the notion of digital materiality. In effect, the material nature of the proposed installation could be formulated in more precise terms than before. Evaluating the material character of the installation did not just mean to observe and explore the sensorial effects of supplied exhibits. Rather, the team had to focus on the interactional effects of the installation – on how the matter 'matters'.

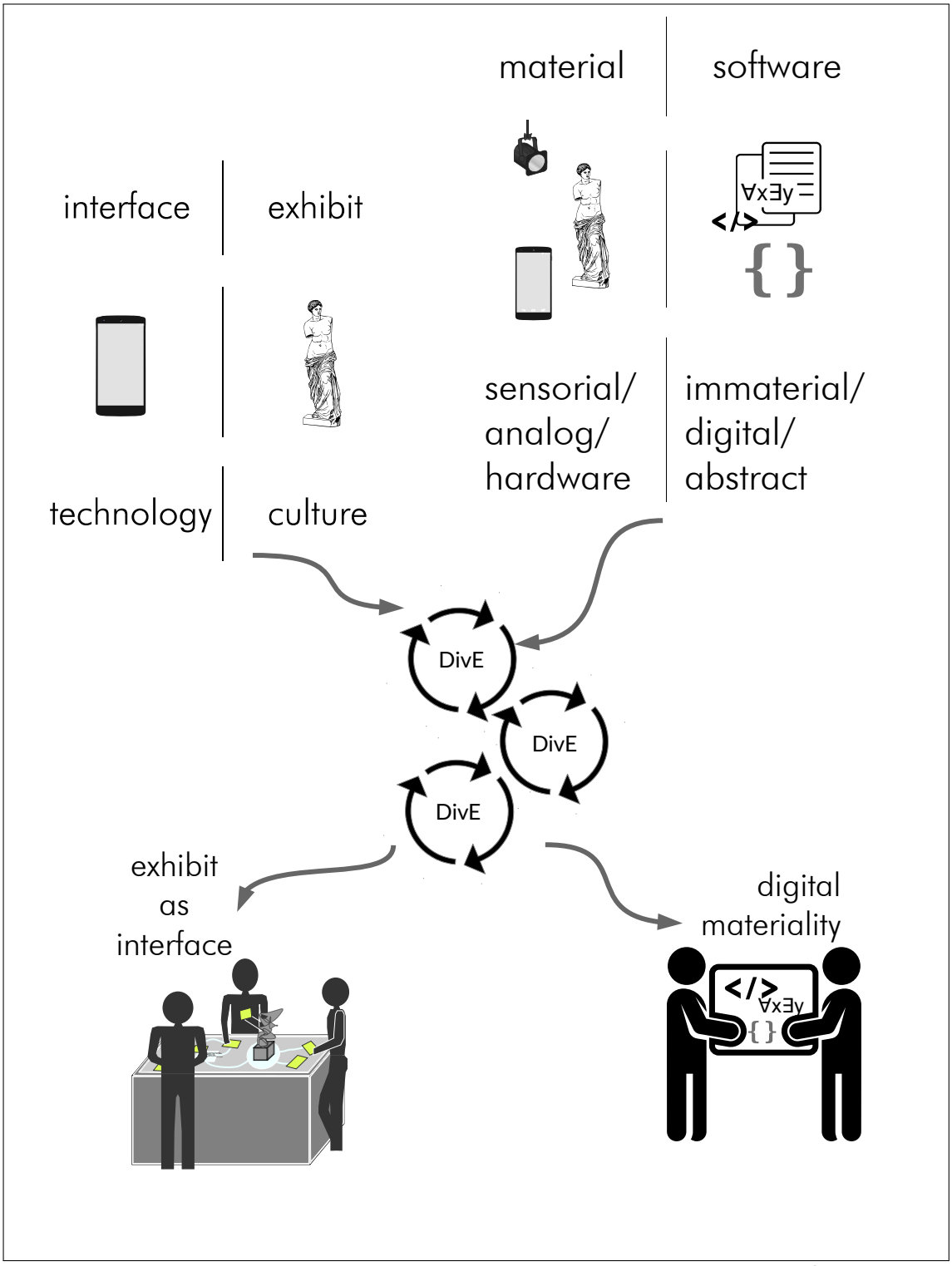


Figure 6.5: Overview of conceptual transformations effected during the ASSMBLG project

Ultimately, effected conceptual reframings allow for a reformulation an renegotiation of the responsibility of digital makers This could further facilitate a reformulation of the responsibility of digital makers as well as reformulation of the notion of argumentation itself.

The complex phenomena of touch and sensorial experience were coupled with the complicated problem of designing informational systems. By putting the exhibit into the centre, thereby making it part of the interface, the strict division between cultural and digital material is circumvented.

7
PRTL – Interactive Installation – Exploratory Practice-Led Study

CODE IS LAW

– LAWRENCE LESSIG

[T]HE POWER RELATION [...] ESTABLISHES CONTACT BETWEEN UNFORMED MATTER (RECEPTIVITY) AND UNFORMALIZED FUNCTIONS (SPONTANEITY). ON THE OTHER HAND RELATIONS OF KNOWLEDGE, ON EACH SIDE, DEAL WITH FORMED SUBSTANCES AND FORMALISED FUNCTIONS BY USING THE RECEPTIVE KIND OF VISIBLE ELEMENT, OR THE SPONTANEOUS KIND OF ARTICULABLE ELEMENT.

– GILLES DELEUZE

Following the discussion of *digital materiality*, detailed within the preceding chapter, the practice of code production itself became subject to negotiation through a process of artefact creation within the project PRTL. Departing from an analysis of the power effects of coded infrastructures, the process led to a practice-based inquiry into the phenomenon of coding. Code, initially construed as a prime example of complication, was

thus retheorised as element within complex social, interactional and political processes. Through the practice-led process, the question how to represent phenomena of coding in the form of an interactive artefact culminated in the construction of a prototype allowing for joint interactive exploration of code.

Consequently, the fifth dimension of practice ("interests, power, and politics", see 2.3) received special attention throughout the negotiation process through inclusion of the political implications of the practice of code making. The PRTL project leans more towards being *practice-led*, exploring the methodology's ability to negotiate and reframe issues social and political. In this respect, it is less goal oriented and more open ended than the preceding two projects, concerning itself with criteria of social relevance entailed by practice-based research.

7.1 Overview

The PRTL project progressed through iterative development of a series of interactive and non-interactive installations. Produced as part of a cooperation with design ethnographer and visual artist Vicki Moulder at Simon Fraser University, it touched upon a dimension of interdisciplinarity more extensive than that of preceding studies.

The initial artefact constructed within the incipient practice-led inquiry was that of an automatic collage generator. It operates by collecting visual and textual content from the social-web. From these digital found objects, collages and information displays are subsequently constructed. During the ensuing practice-based process, the artefact served the aim of negotiating the complications of code and system design with respect to cultural complexity. This first phase of the project, reflectively and through artefact creation addressed the problematic of productive cooperation in the face of severely dissimilar disciplinary backgrounds.

Following introduction of Latourian practice theory, the project culminated in a practice-led inquiry of coding as a complex phenomenon. Within this second phase, an interactive

artefact was developed allowing for interactively experiencing the process of coding itself.

7.2 Development Context

The PRTL prototype was created in close collaboration with Victoria Moulder, a design-ethnographer at Simon-Fraser-University (SFU) with a background in fine art. It deals with the outlined problematic of relating the complexity of political action with the complication of algorithmically supported, web-based image processing. During the portal project the mode of cooperation between researchers itself emerged as content to be expressed as part of a digital artefact. PRTL thus aims to highlight the structure of digital spaces with respect to the possibilities of political coordination.

The context of cooperation amended the interdisciplinary situations facilitated within crossWorlds. It allowed for utilisation and observation of the difference between informatics, design and art. Moulder's experience with fine arts and design provided an additional skill set and perspective to the crossWorlds group. SFU's Everyday Design Studio provided helpful incentives through discussion of experiences concerning Practice-paradigm research relating to the cultural domain[1,2,3,4].

Technical development was based on the existing middleware of the LOOPHOLE project (see section 4.2).

Intellectually, discussions took the artist's previous digital-ethnographic work in the field of social media[5] as a common point of reference. Positions identified were subsequently read on the background of my philosophically informed reflections on the status of aesthetics, which were developed in the context of interdisciplinary negotiation and translation.[6] Especially during the first iterations of prototyping, past work regarding the relationship between HCI and political action[7] were reflected and expanded upon.

My theorising operated on the basis of a practice theoretical approach informed by semiotic-assemblage theory which was met with a critical reading of Lev Manovich's concept of

[1] Ron Wakkary: Framing complexity, design and experience (2005).

[2] Ron Wakkary/Marek Hatala: Ec(H)O (2006).

[3] Ron Wakkary: Design and complexity (2004).

[4] Elizabeth Goodman/Erik Stolterman/Ron Wakkary: Understanding Interaction Design Practices (2011).

[5] Victoria Moulder/Jim Bizzocchi: Transcoding Place (2008).

[6] Kalja Kanellopoulos/Michael Heidt: Stubborn Materialities / Unruly Aesthetics (2013).

[7] Stacey Kuznetsov et al.: HCI, Politics and the City (2011).

transcoding introduced by Moulder. Both approaches concern themselves with the relationship of complicated and complex phenomena but do so in differing manner: Developed in *The Language of New Media*[8] transcoding interprets said problematic through the lens of media theory. An analysis of the structure of digital media is combined with that of cultural forms. The concept of transcoding posits specific patterns of interdependence between both cultural and technical layers. As the development of digitalisation progresses, structures of digital media spill over into the sphere of cultural forms.

[8] Lev Manovich: The Language of New Media (2001).

7.3 Initial Negotiations and Framings

Early prototyping sessions were informed by the classic "hole-in-space" installation[9,10] . Despite its simplicity, the installation facilitated a varied array of practices, enabling chance encounters, exchange of longing glances and ephemeral reunifications. The installation thus creates a strong effect, just through the juxtaposition of images otherwise separated by geographical distance.

[9] Kit Galloway/Sherrie Rabinowitz: Hole in Space (1980).
[10] Thomas Erickson/David W. McDonald: Seeing the Hole in Space (2008).

Project Bootstrapping Initially, project participants appeared highly motivated, yet overwhelmed by the complexity of the subject matter while unfocused regarding construction of concrete artefacts. They seemed to suffer from a lack of direction while produced artefacts did not appear to possess clear qualities of "aboutness". Rather, participants found themselves confronted with a seemingly disparate array of interests, intentions and inspirations. The intent to construct something tangible was not complemented by structures allowing for its specification or framing.

In these early stages, discussion focused on the power dynamics which unfold on the field of the digital. Based on preliminary analysis, a tentative understanding of the problematic of social and political action within the digital realm was developed. Using the political phenomenon of *activism* as a permanent point of reference, the implications of adopting dig-

ital artefacts within activist practice were theorised: One of the challenges facing activist communities was analysed as their geographical dispersal. While political processes unfold globally, practices of mobilisation and discussion have to keep up. Traditional forms of activism, such as demonstrations, necessitate physical co-presence of individuals. These forms of events and coordination thus contribute to the special experiential characteristics of activist experiences while at the same time limiting them in scope and impact. Some forms of activism, such as digital activism, clicktivism, and social-media-activism react to the necessity of global coordination. However, the defining quality of interaction is lost along with valuable forms of communal coordination and collaborative experiences. Furthermore, when employing these practices, the space in which activism unfolds changes. It is no longer the familiar environment of the street or town square but the elusive room of the digital. How to theorise this space in a way allowing for successful artefact construction thus emerged as an open question.

7.4 Collage Generator – Iteration #1

Initially, discussions within the team could not be resolved productively, due to differing intellectual framings and lack of practical compatibility regarding artistic and informatics practices. The team's inability to productively negotiate the cultural complexities of digital spaces and interactive installations, however, led to a productive crisis.

No joint theoretical basis could be agreed on. Transcoding and practice theory remained present as two disparate conceptual framings, introducing an element of tension into the making process.

The perceived impasse could eventually be overcome through a practice of joint artefact production. It was triggered by Moulder creating a collage broaching the issues of activism, as well as the topic of "Crude Awakening" discussed in her previous works. Criteria and decisions underlying making of this collage-

image were subsequently discussed. Negotiating the status of code between informatician and visual artist took the form of creation of an algorithmic device capable of producing visual output adhering to formal “artistic” criteria. Taking up the idea of juxtaposition of images discussed in the context of “hole-in-space”, a web-based collage generator was prototyped and produced.

Collages created by Moulder and collage generator outputs created by me were exchanged in an iterative manner (refer to fig. 7.3 for a series of early algorithmically created collages). Generator output was discussed, while Moulder in every iteration selected a subset of “felicitous” collages that served as basis for my further coding efforts (fig. 7.4).

Artefact Operation – Example Intended to be simple and amenable to clearboxing, the system composes image series according to a set of coded rules. An example set of rules specified is discussed below: In response to a developer supplied query, a series of images is retrieved from the social web. The most dominant colour of each of these images is subsequently computed. By virtue of a different query, images of oblong dimension are harvested. From these, images with high chromatic cohesion are selected. The system then chooses one of the images with high chromatic cohesion which contrasts with the dominant colour of the query-image.

Discussion At this point in the prototyping process I reconstructed the process as being *practice-led*. The process of artefact making did seem potentially more important than the produced artefact itself. The process of making allowed a productive framing and redescription of the practice of collage making and coding. It thus triggered a process of mutual intellectual sensitisation between artistic and informatics mindsets.

7.5 Iteration #2

Following discussions were aided by the presence of concrete artefacts. The artefact and the sequence of images it produces serve as a common point of reference, which can be praised or criticised in a specific manner: 'That is a nice set of images.', 'That does not work yet.', 'There is a semantics to the images that you do not seem yet to understand.', 'This image entails narrative content that you do not seem to grasp.', 'I might have transported the formal composition of your image into code. However, I do not understand how you commented that last image.'

7.5.1 Poster

During these discussions, the *practice of coding* itself came into focus.

In order to render the effects of code tangible, Moulder chose the medium of an informational poster. The code-based artefacts produced by the informatician were thus retranslated into the sphere of the visual by the artist. In an attempt to reconstruct code based coupling she designed a poster (fig. 7.5), relating bits of code with visual output.

Intended for presentation in the vicinity of the coded artefact, it highlights and explains the inner mode of operation of the coded system.

7.6 Seattle Hackathon & Mobile Exhibitions

In order to tease out the effect projections would have in various situations, a practice of mobile exhibition was envisioned (fig. 7.6).

Using lightweight and pico-projectors, the effect of different modes of situating projections were explored. Prototype output was projected at various sites on the SFU campus (fig. 7.2).

Additionally, the prototype was presented at a Hackathon in Seattle on the topic of civic infrastructure.

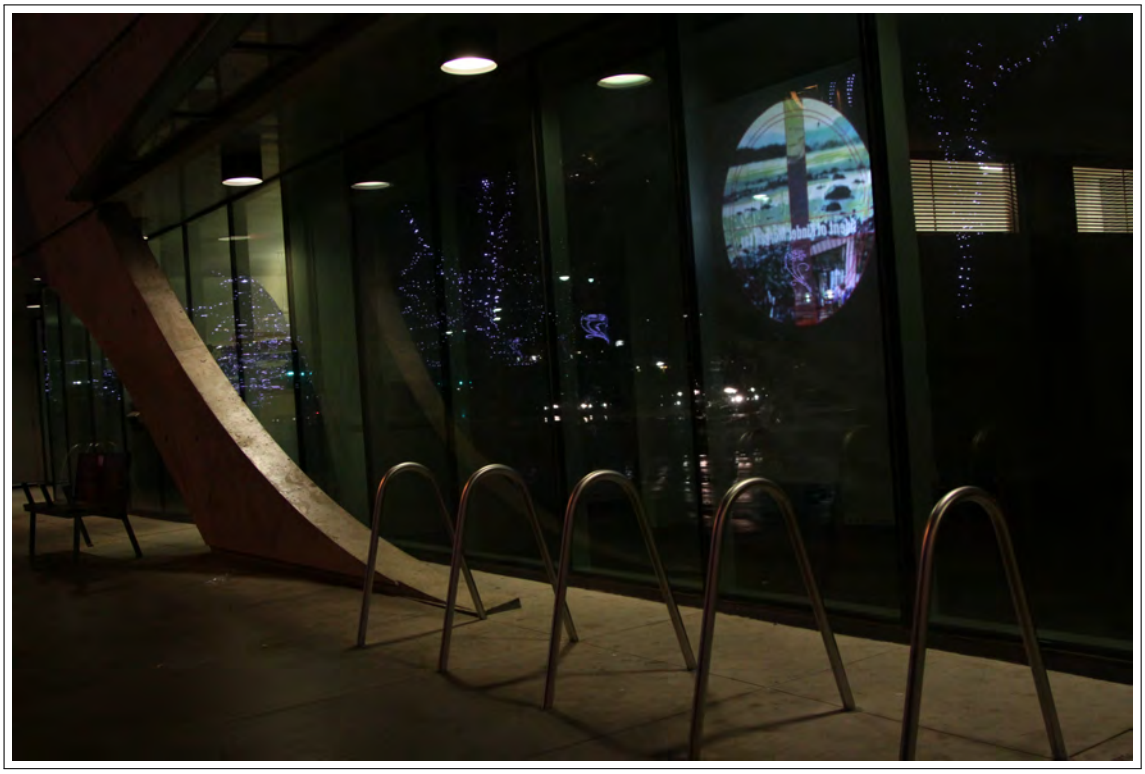


Figure 7.1: PRTL – Projection at Surrey City Centre Library

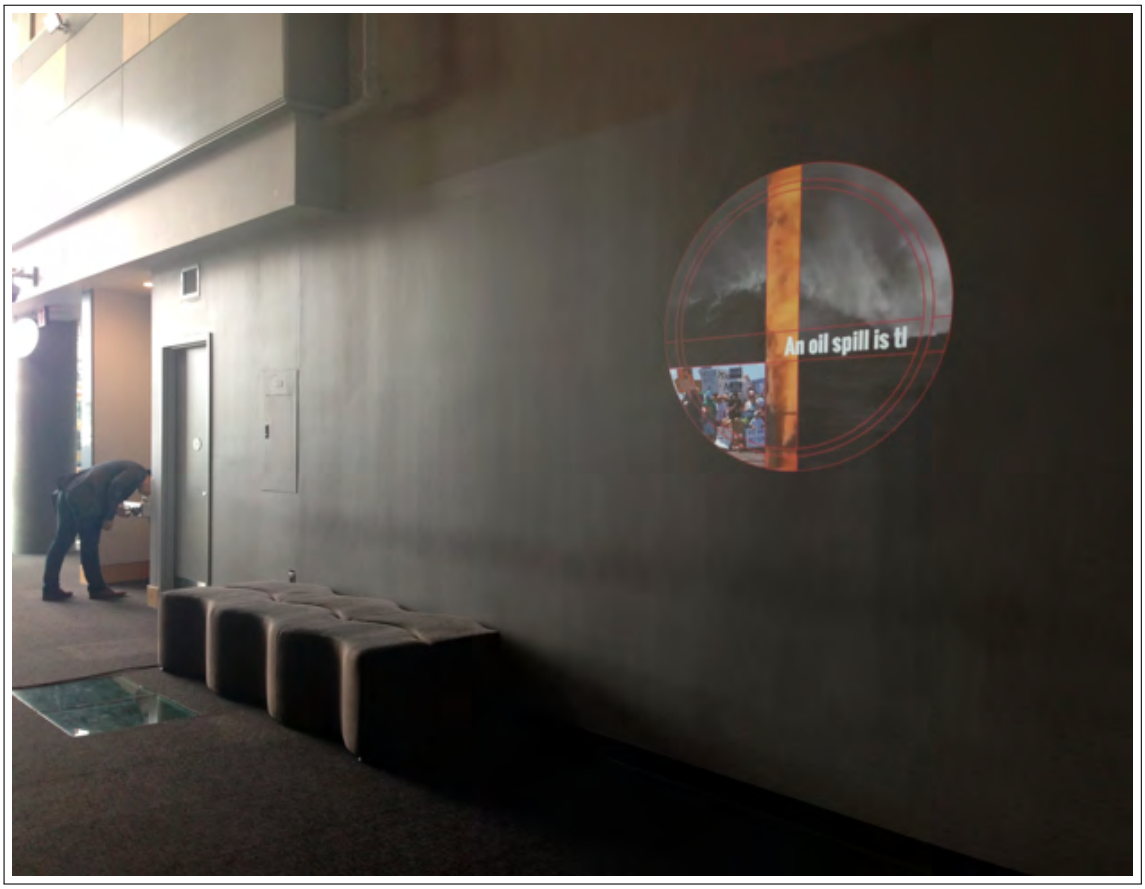


Figure 7.2: PRTL – Projections at SFU

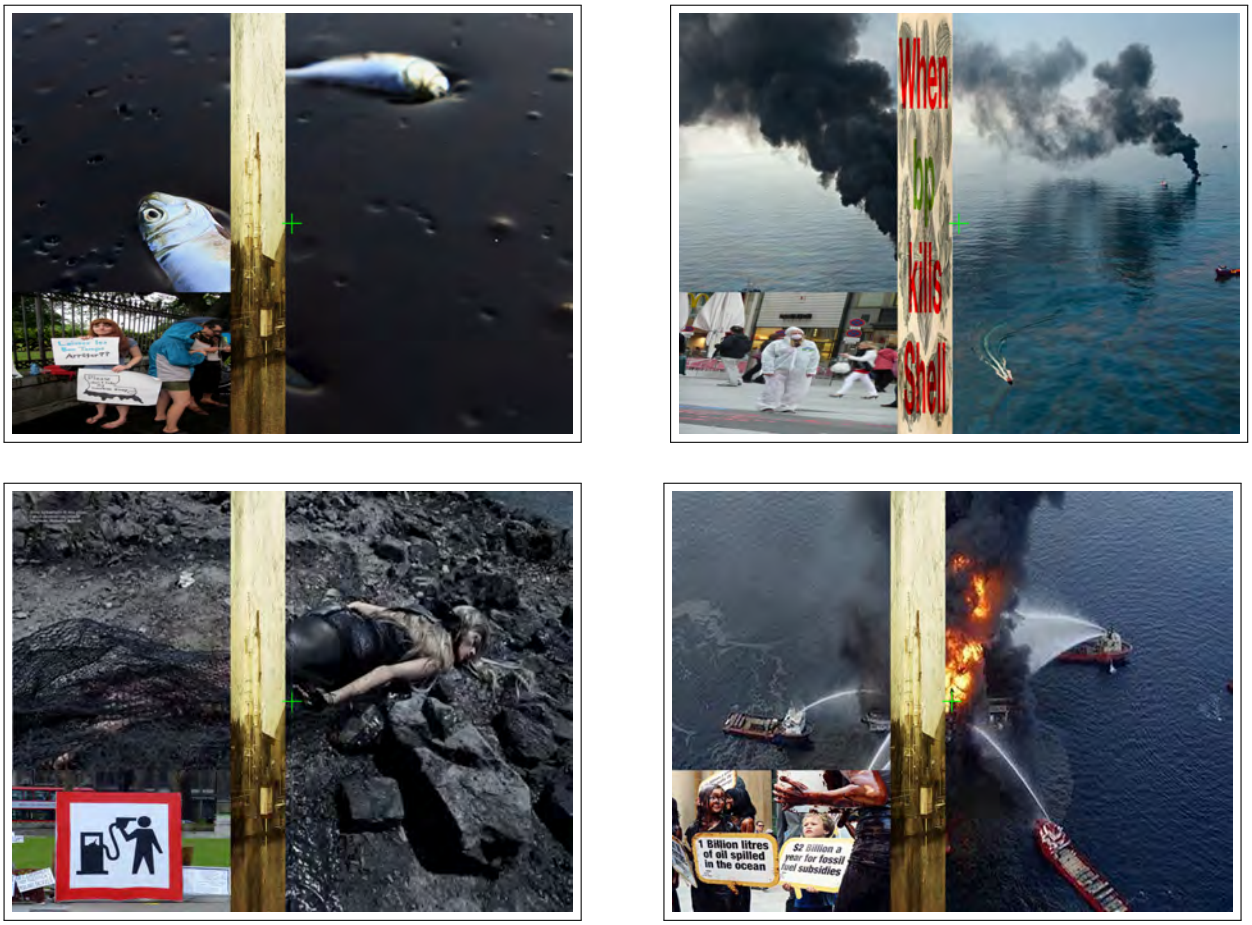


Figure 7.3: PRTL – System Output – "Curated" by Visual Artist

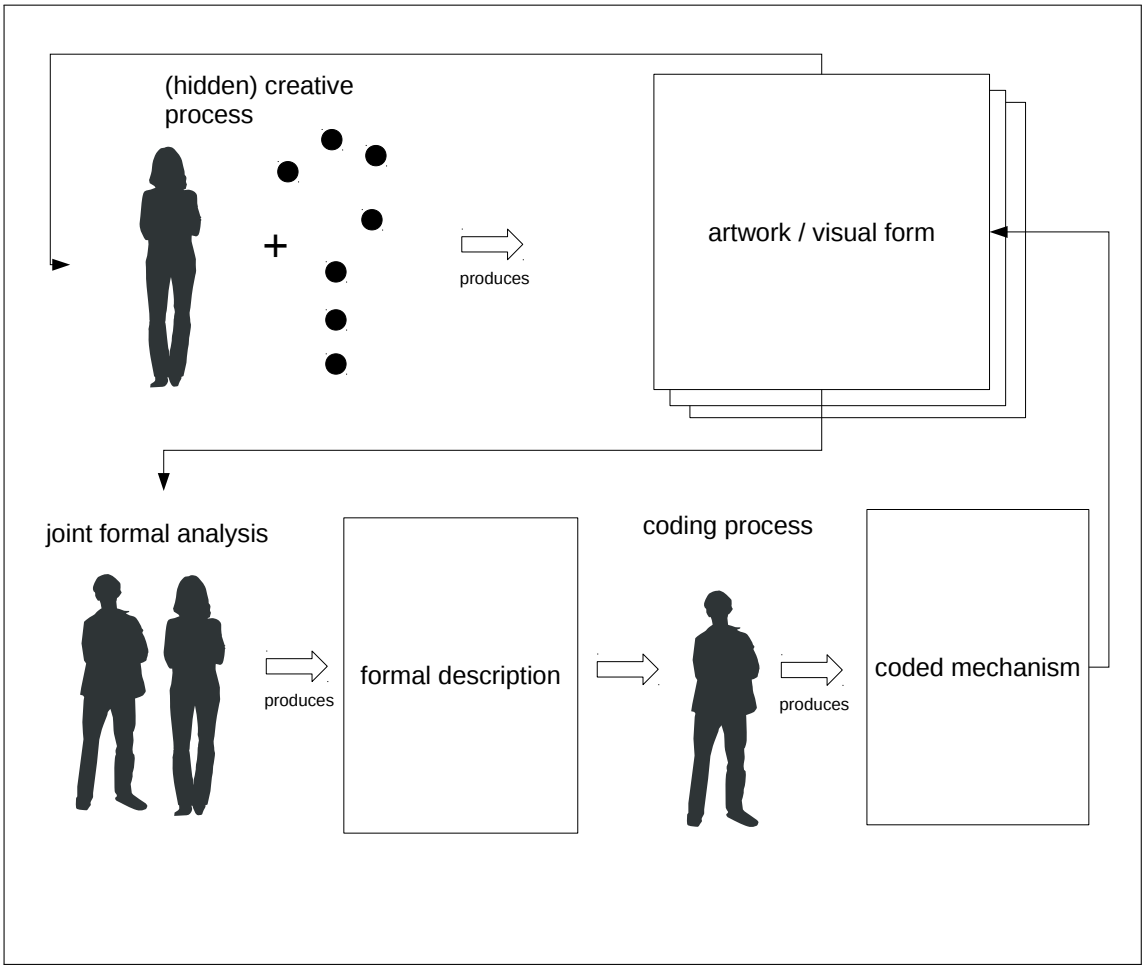


Figure 7.4: PRTL – Structure of Interdisciplinary Negotiation of Algorithmic Collage Generator

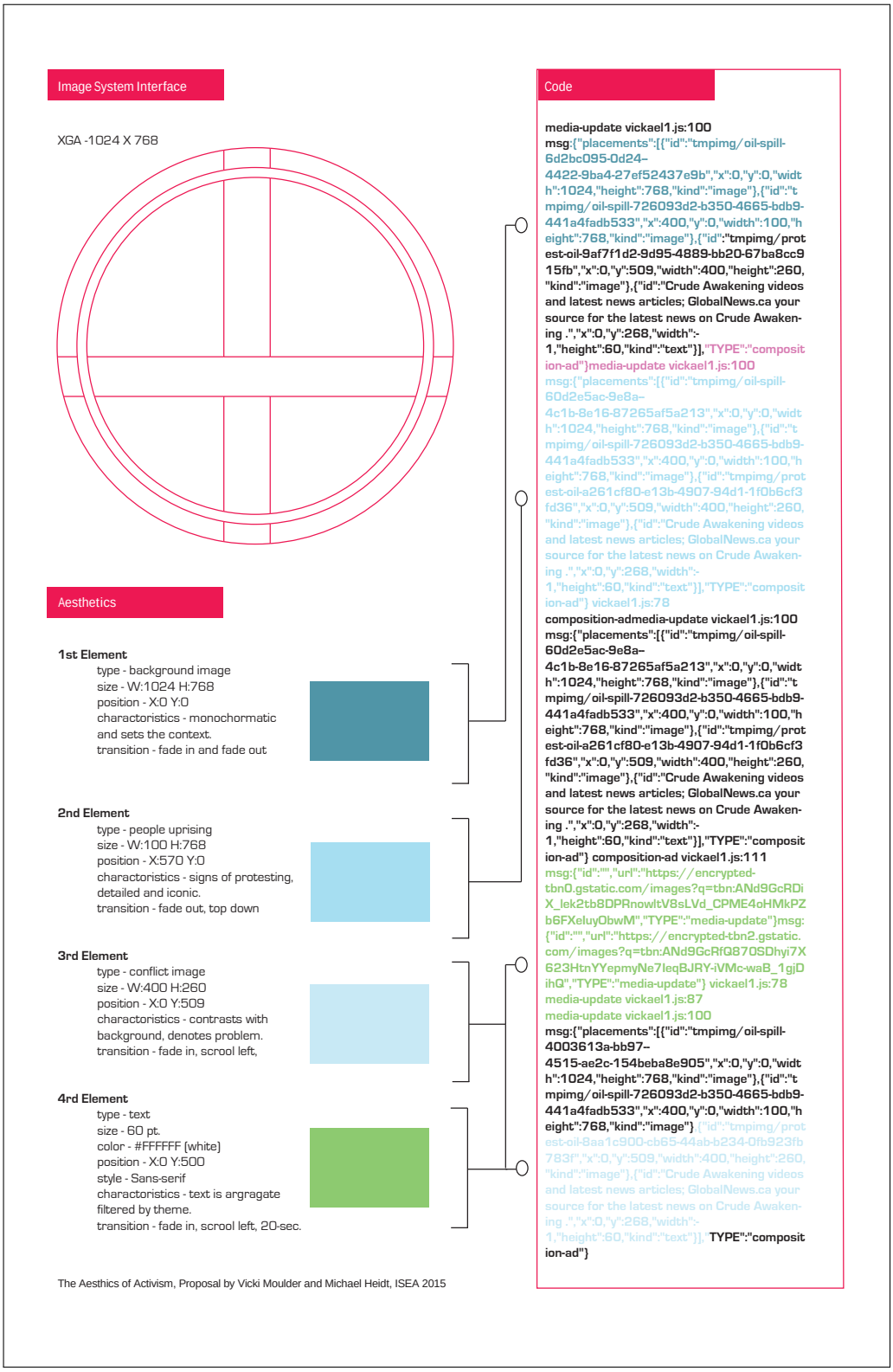


Figure 7.5: PRTL – Code Poster, Initial Draft – Image Courtesy of Vicki Moulder

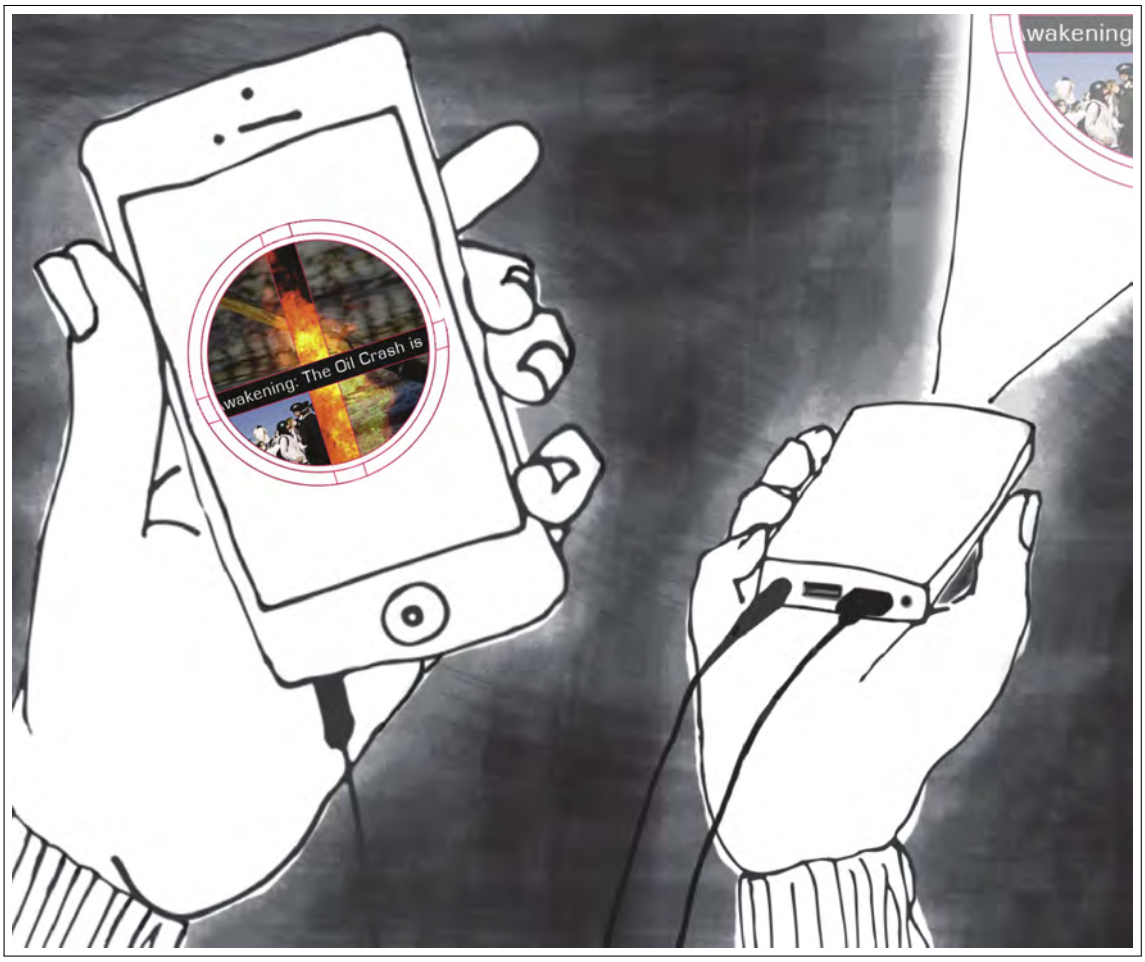


Figure 7.6: PRTL – Pico Projection Scenario – Image courtesy of Roberta Batchelor and Vicki Moulder

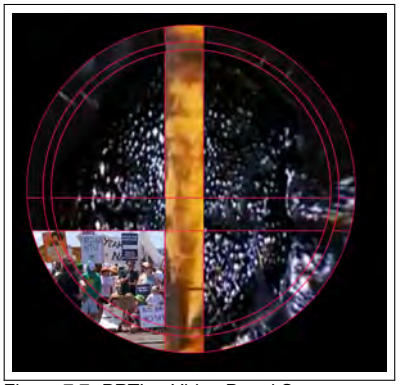


Figure 7.7: PRTL – Video Portal Screenshot

Short and informal open ended interviews were conducted by myself, antecedent to showing the artefact to users. User reactions were positive; many users pointed to the similarity between portal design and a reticle, as present within sighting devices (fig. 7.7). User artefact interactions typically were short, they would look at one to three produced collages, resulting in a total view time of 30 seconds to one minute.

The structure of the algorithm producing collages, however, remained absent from discussions. In the context of non-expert users, verbal explanations remained unable to communicate algorithmic structure. Despite its relative simplicity, viewers articulated to be overwhelmed by the evoked level of complication.

From my perspective the artefact needed to point towards its inner coded logic in order to be effective. Developed artefacts, however, proved inadequate to communicate algorithmic structure through exhibited visual material. Most of the time, computed images were not identified as being curated by an algorithm. Furthermore, the attention span of users did not seem sufficient in order to gradually grasp the coded logic behind what was shown. Consequently, different modes of presentation had to be found.

7.7 Iteration #3

7.7.1 Comma

In reaction to the artefacts' inability to point towards code based processing, the mode of presentation was changed in the course of development of a novel prototype called *comma*. A main desideratum was seen as foregrounding the effect of the collage generator as producing a *sequence* of images. In order to foreground the seriality of image production, the system no longer displays single collages. Instead, a series of generated collages is displayed, while individual elements within the series are separated by big commata. The commata themselves

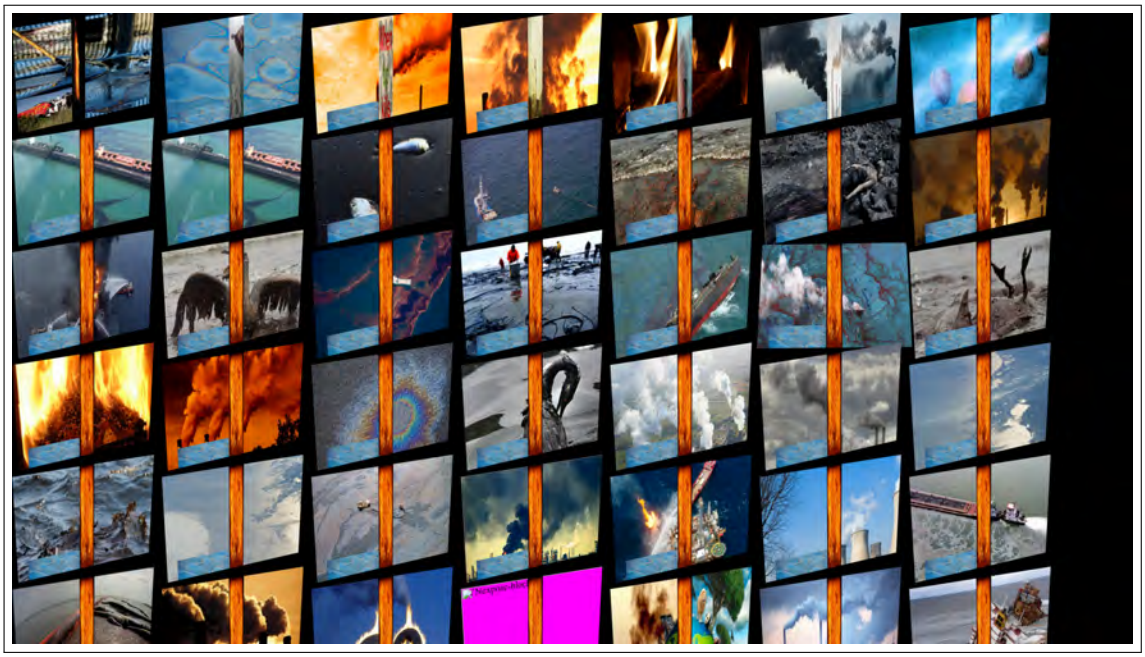


Figure 7.8: PRTL – Sequence Prototype, Screenshot

were eventually dropped in favour of a simple grid layout (fig. 7.8).

7.7.2 Coding Floor

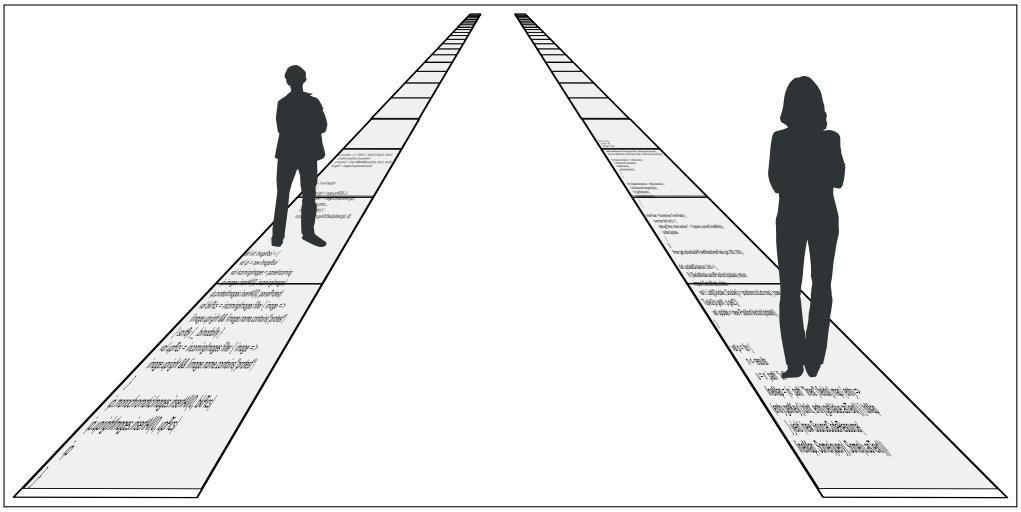


Figure 7.9: Coding Floor – Concept Drawing

I attributed many of the difficulties in conveying the algorithmic characteristics of previous pieces to the abstract nature of

code. Since mutual sensibilities had already been developed within the project team, the artefact's primary audience initially was the project team itself.

It became apparent that the practice of coding would remain opaque if communicated exclusively via discursive means. The practice had to be translated into a more tangible form in order to become communicable. Especially the experiential quality of coding as expression remained hard to convey. Terms such as 'creativity' and 'expression' used to describe coding, were fraught with connotations that might be misleading. The specific difference between creativity within the realm of the arts and the practice of coding remained outside of conceptual access.

With recourse to an overarching interest in 'connecting users', an interactive installation for two users was created. The aim was to connect participants through interaction in a manner evoking a joint experience of the coding process.

Prototype Structure In order to be represented within a short interactional setting, the practice of coding had to be simplified enormously. Hence, the creative specification of arbitrary structures possible while producing code was limited to a practice of *choice*.

Users move within an interaction zone in front of the projection. Code segments are extracted from the codebase of the created collage generator. These bits of code are displayed on the projection; depending on users' positions, different bits of code are executed while their effect is visualised instantly.

Projection space is subdivided into a plane in the front and a backdrop area behind the floor. The plane is lifted perspectively, pointing towards the backdrop holding constructed images (fig. 7.10).

Predefined fragments are placed within the plane; the interaction space is subdivided into areas mapped to fragments. Mapping between areas and fragments remains static. User's positions are coupled with cursor positions on the projection. Depending on cursor positions, different pairs of code fragments become active.

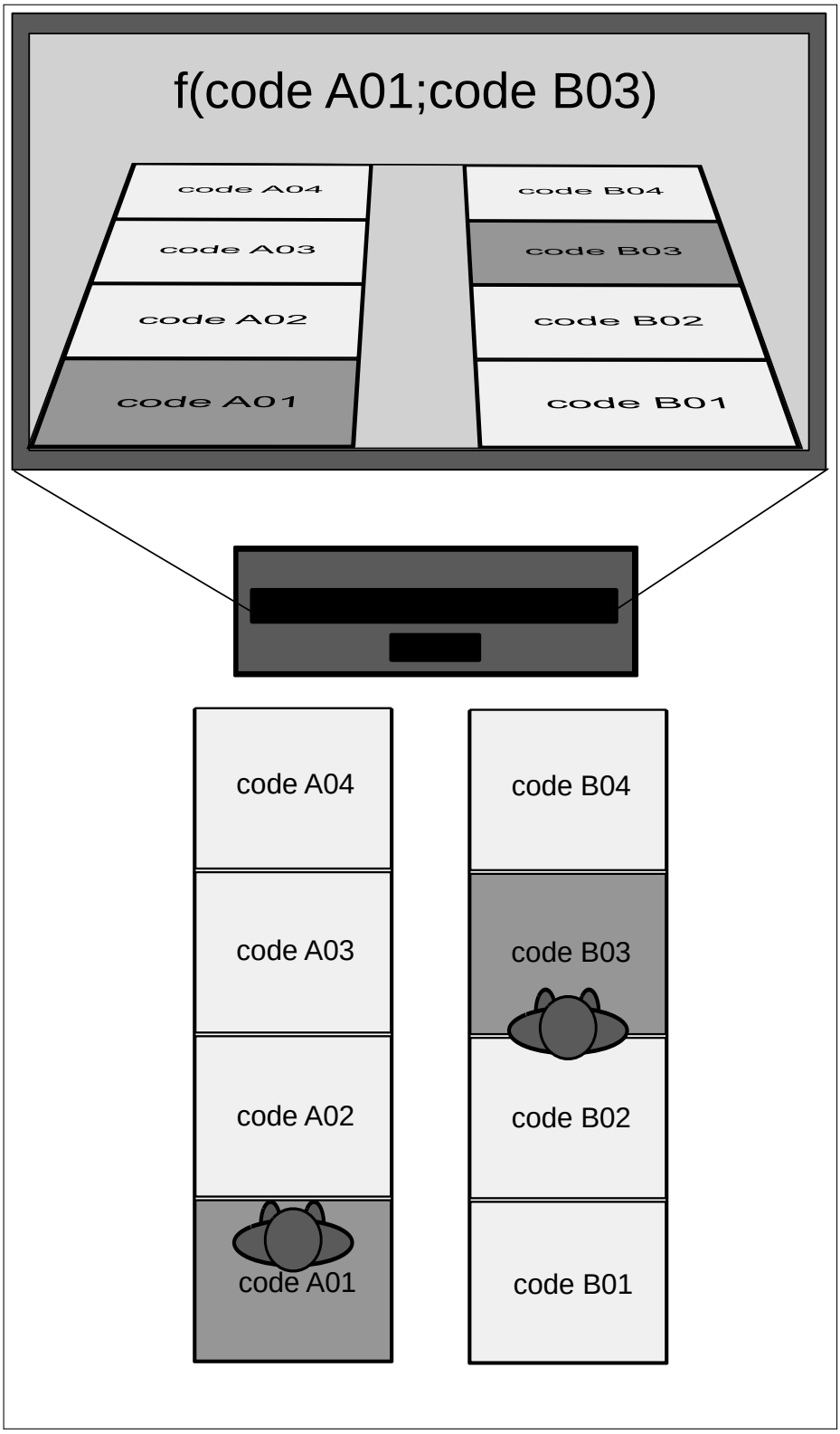


Figure 7.10: Coding Floor – Prototype Layout

Chosen fragments are concatenated, forming an operational element of code. If user A is standing on code fragment C_a while user B is standing on fragment C_b, the produced block of code would be $C_aC_b =: C_r$. The effect of C_r is subsequently shown within the backdrop area. As participants move through the interactive zone, their position determines the choice of code fragment. Effects of produced functions are displayed instantaneously within the projection backdrop area.

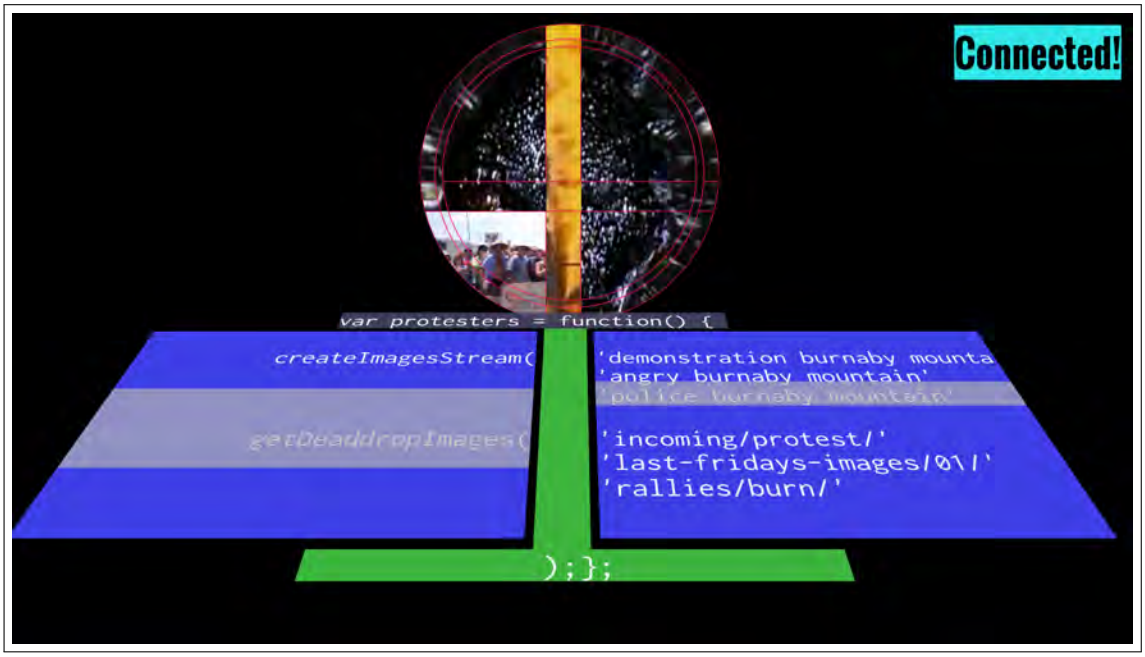


Figure 7.11: Coding Floor – Glasgow Prototype, Screenshot

Discussion The artefact was subjected to studio critique and shown as component of a demonstration at the conference ACM Creativity & Cognition 2015 (fig. 7.11). Initial feedback was positive. In contradistinction to other prototypes, users commented on the nature of code and digital material. However, the corresponding iteration is still ongoing. Within evaluation sessions code fragments and execution outcomes were limited to a statically defined set of elements. Technical issues remain, functionality of the digital prototype is still limited and the process of artefact evaluation thus is not yet complete.

Through the developed setup, the process of coding was imbued with performative elements. It became possible to perform the process of coding for an audience, similar to practices of *live-coding*[11,12].

This embedding of the complicated matter of code into complex practices of performance facilitated discussion of subject matter that otherwise appeared to be too abstract for the layperson.

[11] Nick Collins: Live Coding of Consequence (2011).

[12] Alex McLean: Textility of Live Code (2014).

7.8 Conclusion

Project participants sensitised each other towards the particular traits of respective disciplinary practices through a communicative process of artefact creation and exchange (see 7.4). The interactional character of producing code could subsequently be expressed in the form of an interactive artefact (see 7.7.2). PRTL thus showed how performative clearboxing can allow for code-based artefacts to be successfully negotiated within interdisciplinary contexts. As a result, the process of code production could be analysed as a practice mediating between complexity and complication.

8
Methodology

A methodology is proposed for managing everyday cultural complexity with respect to development of interactive digital artefacts. It expands on the notion of the *hybrid project*, discussed in chapter 3, combining features of technology orientation and purely practice-based research projects. The developed methodology, called DivE, is based on the idea of clearly expressing disciplinary differences, rendering them productive in a joint process of making, rather than trying to pacify them.

With recourse to the concept of the *boundary object* (see 2.4) difference and dissensus are employed as productive assets during interdisciplinary prototyping processes. Computing-related activities, such as code production, are situated within a practice-based research methodology in order to make them communicable and productive.

Development of the DivE-methodology occurred within the context of concrete interdisciplinary development projects. The methodology itself was developed, refined, and altered within a process of iterative interdisciplinary negotiation. Thus, it is the result of a labour-intensive methodological “bootstrapping-process” whose steps will and cannot be detailed in full. The discussion presented in this chapter thus details a disinvolved model of a structured process developed and matured during concrete practice-based projects. The process of its emergence and patterns of its application have to be reconstructed vis-a-vis concrete making processes.

8.1 Development Context & Motivation

The methodology itself was conceived in reaction to the challenges of disciplinary heterogeneity. Namely, the tasks of creating interactive installations for museum and exhibition contexts. Specifically, it was conceived in order to inform development of the full-body interface PRMD (see chapter 5), the tangible tabletop interface ASSMBLG (see chapter 6), and the interactive installation PRTL (see chapter 7).

Initially, the activity of interdisciplinary prototyping found itself confronted with huge obstacles. Methodological convictions and theoretical commitments differed wildly among project participants – leading to frequent strife and repeated misunderstanding. Resultingly, argumentation complexity eclipsed constructive efforts of prototype construction. At the same time, the constructive process remained stale and inefficient without impulses from social research. The complicating practice of informaticians required construals of complex social practice as an input, without itself possessing the communicative and methodological means for processing accounts of complexity. To overcome these obstacles, a methodological prototype was required, in order to serve as provider of boundary objects between participants possessing dissimilar disciplinary backgrounds.

8.2 The DivE Process

A DivE process is a joint effort conducted by a project team aimed at producing digital artefacts and discursive concepts. Its sphere of application is complex target domains, such as cultural institutions. Artefacts produced are intended to modulate or alter systems of practice within these environments. Concepts formed facilitate interpretation of said artefacts while highlighting relevant social phenomena and cultural issues.

DivE proposes a set of structural elements to be followed during a joint interdisciplinary project. As such, it exhibits some structural similarities to methods in software engineering and

design, specifically to agile methods (see section 8.6 for a discussion of the relationship between DivE and existing methods.)

The DivE process itself is tripartite in nature, consisting of the following phases (see fig. 8.1):

- *Initial Phase*

  Project participants enter into a process of mutual sensitisation. They negotiate project parameters and create a joint research frame.

- *Main Poietic Phase*

  Iteratively, participants create artefacts and concepts. Steps of antagonistic debate and joint making are integrated within the framing developed previously. Usually, it is the most long-running phase by far, comprising the main practices of making and theorising.

- *Consolidation Phase*

  Participants consolidate generated knowledge through theory building and/or by developing prototypes into artefacts ready for deployment within complex situations of use.

  Subsequently, each phase is described in more detail:

8.2.1 Initial Phase

The aim of the initial phase is to establish a joint *research frame* within which, and against which, joint processes of making, negotiation, and argumentation can operate (see 3.2.3). A research frame contains the research questions informing the joint project, the context for the project (such as sites at which artefacts will be deployed), and a list of possible methods for working on the research questions. It furthermore contains an agreement regarding the mode of cooperation, such as the way meetings are conducted and measures to ensure joint access to built artefacts.

The DivE-process commences with identification of relevant problems, cultural practices, and theories. Initial discussions

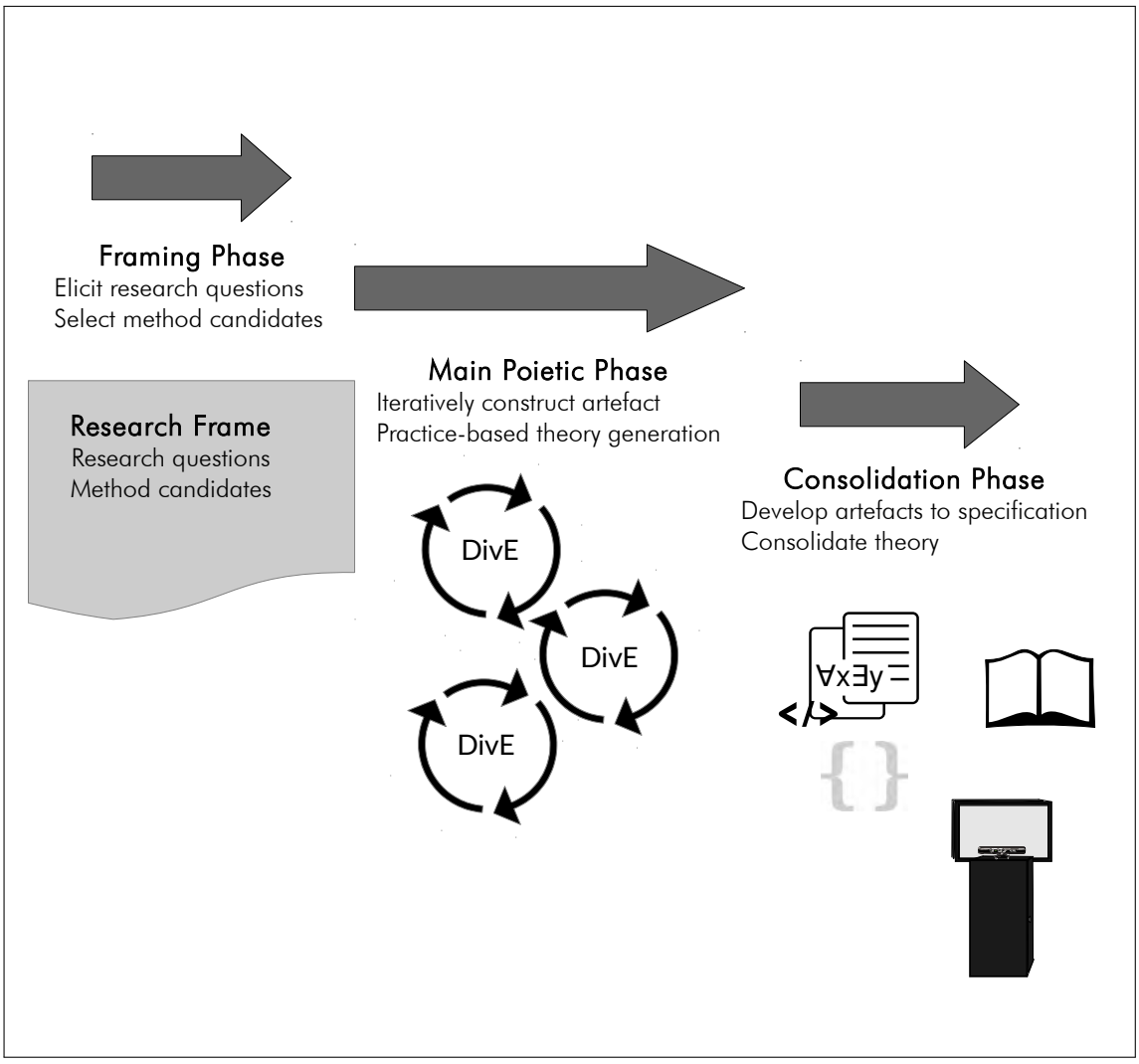


Figure 8.1: Phases within the DivE Process

serve to identify mutual interests and preoccupations. Building on these elements, participants identify concrete pre-existing concepts and artefacts related to their interests.

In order to inform meaningful discussion, allowing for understanding and confrontation across disciplinary boundaries, participants are encouraged to develop a joint *theoretical framing*. To this end, a shared set of concepts is introduced and discussions aim at providing an understanding of individual construals of the theory in question. The goal of this step is twofold: to both provide a shared vocabulary of concepts, while allowing participants to develop their own readings of the theory in question and subsequently communicate differences regarding individual construals. The mutual discussion process thus aims at communication of differences between individual *readings* of a shared theoretical base. DivE's theoretical framing is described in more detail in section 8.5.

Subsequently, participants identify relevant problems and open questions related to concepts, artefacts, and theories previously designated. According to interests and disciplinary backgrounds, they expand these problems into goals amenable to technology research projects and/or develop them into issues and concerns suitable for informing creative-production projects. Participants then create a joint list of open problems. Lastly, they derive a tentative list of preliminary research questions from the set of open questions. The research questions themselves, as well as the disciplinary concepts they are articulated with, will usually differ among participants. Crucially, DivE does not try to force an agreement regarding the guiding research questions. Instead, research questions are to be aligned in a way that allows a common course of action regarding practices of artefact construction to emerge: If two sets of research questions are framed in different languages but point towards a common course of action regarding constructive practice, they are considered adequate regarding the joint research frame.

With the preliminary list of research questions in place, the process focuses on identifying methods suitable for pursuing

said questions. Participants identify candidates for methods, discuss their characteristics, implications, and peculiarities. Ideally, all participants get acquainted with the full scope of methods to be used during the main-phase. However, as a project can take unexpected turns leading the process in unanticipated directions, it always remains possible to add methods at a later stage.

In order for methods to become fruitful within a practice-based theory building process, their (oftentimes implicit) theoretical commitments and foundations have to be unearthed, analysed, and discussed. Discussions have to clearly delineate what it means to employ a certain method. Furthermore, identified theoretical commitments have to be discussed in relationship to respective disciplinary epistemological commitments on the part of project participants.

It has to be noted that choice of methods does not occur in the initial phase on the level of the joint project as a whole, instead being reserved for iterations within the poietic main phase. However, individual participants might conduct their own individual projects of theory making, out of choice or out of necessity (e.g. a social researcher conducting a research project, a designer conducting an evaluation project). Within these individual projects, choice of methods might occur sooner. Articulating and discussing these choices and commitments is part of the discussion project within the initial phase. This allows for participants' individual projects and the DivE-process to be productively interrelated: Memos written as part of a grounded theory project can inform discussions within the DivE process. Situational maps can guide processes of interpretation and theory-making within DivE. Processes of theoretical sensitisation[1] within GT projects can be intertwined with processes of mutual sensitisation within DivE. Data collected during ethnographic projects (such as pictures and videos) can serve as point of reference for activities of studio critique, speculative scenario building, and interpretation of artefacts. Furthermore, discussing the structure of individuals' projects will allow team

[1] Juliet M. Corbin/Anselm Strauss: Grounded theory research (1990).

members to form expectations regarding the structure of results produced by respective participants.

Furthermore, participants negotiate parameters of cooperation during the initial phase: They agree on mutual responsibilities, decide on pragmatic matters such as the frequency and structures of meetings, the set of communicative tools used for coordination, and similar questions.

Since, typically, no artefacts have been constructed at this time and no deployment within situations of use is possible, discussion processes are informed by existing artefacts, and possible patterns of use are reconstructed from preexisting studies, and speculated upon using fictitious scenarios and performative devices. Simple ad-hoc paper prototypes and similar means are used to illustrate and contextualise arguments.

Crucially, during the initial phase, participants enter into a process of mutual sensitisation regarding disciplinary practices, differing epistemological commitments and diverging motivations: Code makers explain what it means to them to create digital artefacts, ethnographers describe their approach towards culture, designers communicate their construal of practices of artefact-making. These clarifications are especially important, since there often is no clear-cut correspondence between a method and its epistemological and theoretical commitments: Ethnography can be conducted both from a realist and a constructivist perspective; code makers might remain epistemologically agnostic or have strong commitments regarding the status of digital structures.

These processes of sensitisation are facilitated by miniworkshop situations that help with elucidating others' practices while encouraging temporary role swaps: Digital makers explain what it means to construct software and write code. Developers pose a simple software creation task. Social researchers are asked to develop an algorithmic solution to a concrete problem and translate it into pseudo-code. Social researchers present code makers with a simple task occurring within their theory making processes, such as creation of a

situational map. While these measures will not enable a social researcher to construct software systems or a computer scientist to generate social theory, they lay the groundwork for productive processes of discussion. The goal is not to establish a common language but to grasp the otherness of participants belonging to different disciplinary communities.

The initial phase ends with communication of a joint research frame. The frame provides a tentative communicative structure within which, and against which, subsequent processes of making and theory building can operate. The research frame explicates differences between participants' perspectives and goals, while documenting common goals regarding the direction of material artefact production. It contains a list of candidates for methods to be utilised during processes of observation and evaluation. Furthermore, it entails an agreement regarding the intended context for joint making efforts.

Definition of the research frame concludes DivE's initial phase and marks transition to the main poietic phase. This second phase proceeds according to the joint trajectory arising from relationships and tensions between participants' goals and research questions.

8.2.2 Main Phase

With the guiding questions and theoretical frameworks in place, participants are now able to commence the practice-based process proper. The main phase consists of a series of *iterations*: Each iteration effects a change of the material configuration constituting the artefact and/or an enrichment of the conceptual apparatus informing communications within the project. Conceptual elements, in turn, are employed to interpret both the artefact and the complex social practices it relates to.

An iteration constitutes a temporally limited, internally structured organisational building block within a project: It has a beginning and an end; its structure is recognized by all participants within the process. DivE's main phase thus unfolds as a sequence of iterations. While the DivE process itself is long-

running and need not exhibit an agreed on ending or outcome, the duration of iterations is short in comparison. All project participants need to be in agreement regarding the iterative structure; consensus has to be established as to when an iteration starts and ends. At the same time, substantial divergence can exist regarding an iteration's precise goal, since the very language to communicate goals and motivations only gradually emerges as the joint making process progresses.

8.2.3 Anatomy of an Iteration

An iteration within DivE is a structured set of activities effecting a change within the artefact and/or the conceptual apparatus employed by the project team. Thus, every iteration comprises activities of artefact creation and interpretation. It organises participants into practices of joint artefact construction and encourages observation of altered artefacts within contexts of use.

An iteration within DivE adheres to the following structure (see fig. 8.2):

- **Open Dialogue**

  Every iteration starts with a process of open dialogue. Participants outline and discuss their current interests and motivations, describe relevant concepts and theories. They reflect on past performances of artefacts within the process and explain how these shaped their current perspectives and preoccupations. The goal is to provide a comprehensive outline of participants' thinking and to familiarise them with each other's mindsets.

  In the case of the very first iteration within the process, they reflect on the performance of preexisting artefacts or on observations made during pre-studies as part of the project's initial phase.

- **Divergent Discussion**

  Building on these observations, participants identify the most salient issues and problems. They detail why they think

these are of preeminent relevancy at this juncture of the process. Participants begin to debate which questions to pursue in the course of the current iteration, each making their case on the level of discourse. The discussion process will typically remain to be divergent at this point, with participants' motivations and interests pointing in different directions, unfolding on different levels of analysis, and being framed within differing disciplinary discourses.

- **Artefact Focus**

  Building on the discursive theoretical framing established during the initial phase, participants now frame their concerns in relationship to the artefact. For every issue or problem outlined, they detail how it relates, or would relate, to the built artefact. At this point within the process, motivations typically still remain divergent. However, the artefact serves as a focal point of the discussion process, allowing a joint momentum to be gradually mobilised.

- **Material Argumentation**

  At this point of the iteration, participants aim to reach common ground regarding a suitable set of material changes to be applied to the artefact. To this end, they suspend divergent argumentation on the level of theory, instead focusing on the *artefact's materiality*. They establish a heads of terms, stipulating how to conduct the remainder of the iteration: Participants agree on a set of material changes to the artefact and detail their respective research questions as far as they relate to said changes. Both the agreed on changes and a list of research questions become part of a practice based plan, subsequently directing the team's efforts.

- **Implementation of Changes**

  Participants remake the artefact according to the practice-based-plan. This step can be fairly trivial or constitute a complex endeavour in its own right. In the case of technologically challenging alterations, the implementation step might in itself be structured incrementally or iteratively.

- **Expectation Shaping**

  With the novel artefact in place, participants revisit their previously established research questions. They inform each other about the types of observations pertinent to these questions and describe how they expect the artefact to contribute relevant data. Drawing on concepts, interpretations, and theories previously articulated, they detail how to conceptually account for the artefact's expected performance.

- **Choice of Methods**

  Participants debate which methods are suitable in order to produce the kind of observations and data characterised in the previous step. They jointly choose from candidate methods identified during the project's initial phase, thereby completing the practice based research plan for the current iteration. Crucially, methods should be able to contribute insights relating to every participant's research questions. Participants describe their, possibly divergent, expectations in relationship to the structure of expected data, conditioned by chosen methods.

- **Situational Back Talk**

  Participants deploy the artefact into a situation of use or interpretation, allowing for expectations to be confirmed or irritated. They apply agreed on methods in order to observe engendered patterns of practice. The artefact thereby acts as complicating material frame, creating a point of confrontation between complicated artefact and complex social practice. Since expectations were recorded previously, the situation is able to 'talk back' to researchers, creating the possibility of surprise and validation. Typically, these surprises will present themselves in a different manner to individual participants, since their expectations were different from the outset.

- **Interpretation of Results**

  Using the theoretical framing in place, participants make sense of generated data and interpret the artefact's antecedent performance. On the basis of these findings, they

adjust theories, form new concepts, and develop novel interests. The discursive discipline encouraged by the heads of terms is lifted at this point. Resultingly, individual readings are once again free to engender controversy and strife, to produce misunderstanding and conflict, to inform theoretical struggle and invigorate debate. Hence, the discussion process resumes its divergent character – the iterative process is ready to start anew.

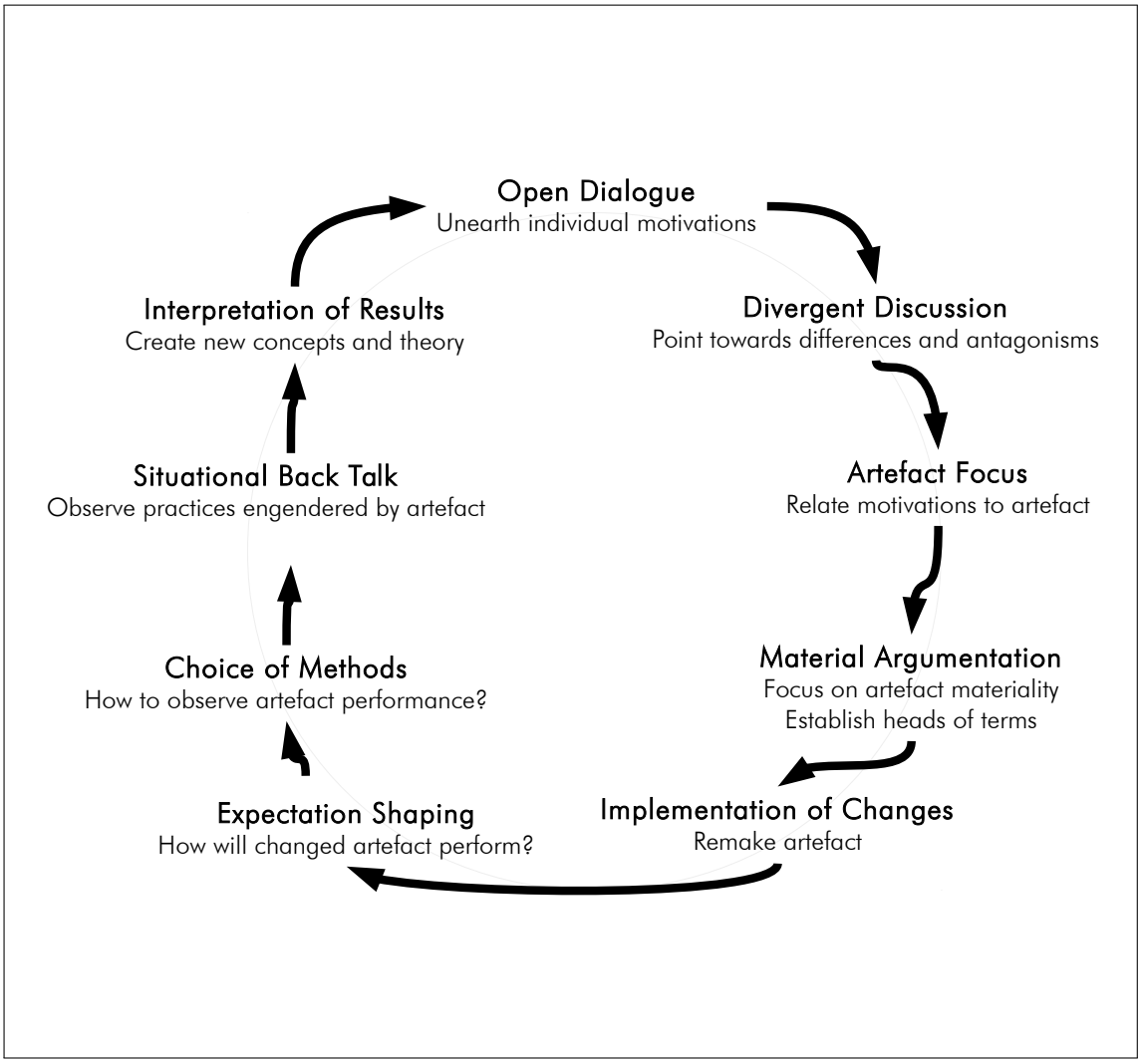


Figure 8.2: Anatomy of an Iteration within DivE

8.2.4 The Iterative Process

Each iteration within DivE involves a temporary consensus on the level of artefactual materiality while simultaneously forcing participants to adapt their conceptual apparatus on the level of theory. It is this dual dynamic that drives the process as a whole: It must provide adequate degrees of freedom for individual disciplinary activities to unfold, for epistemologically distinct theories and methods to be brought to bear. At the same time, it is imperative to ensure a requisite level of coordination in order to inform joint making practices.

Achieving both goals necessitates a temporary disentanglement of the levels of argumentation and construction. This split into materiality and theory is prepared within the **artefact focus** step and fully implemented within the step of **material argumentation**.

Crucially, iterations also describe a continuous traversal between complexity and complication. The **situational back talk** step encourages relating complicated artefacts and complex social practice. The step thereby necessitates practices and concepts originating within the project to relate to both classes of phenomena.

The final **interpretation of results** step marks re-entanglement of the levels of theory and materiality. This is necessary in order to facilitate theorisation of observed phenomena in their entirety, to allow for relationships between complex and complicated elements to be accounted for. The entanglement of these two levels also necessarily means relinquishing the temporary consensus achieved through the previously established heads of terms.

After completion of an iteration the abstract disagreements encountered during the **divergent discussion** step will have become a materially informed dissensus, allowing participants to express how their concepts oppose and complement each other. This sets the stage for further explorations not only into the complex territory of practices of use, but also into the curious languages of other disciplinary cultures.

Individual types of activities to be undertaken within individual steps are discussed in section 8.3.

8.2.5 Consolidation Phase

Participants negotiate when to halt the iterative main phase. This can either take the form of establishing criteria for completion of the joint process or of reaching a simple agreement to suspend the iterative practice-based development process.

At this point, the DivE process can either dissolve or continue within a cooperative setting. In order to make use of concepts and artefacts created during the main poietic phase, participants will typically engage in practices of further development of artefacts into deployable prototypes or integration of concepts into a theoretical whole. Depending on participants' interests and motivations, activities antecedent to DivE's main phase can comprise: Writing up a research report in the case of Grounded Theory Methodology, further iterative artefact development in order to facilitate more permanent deployment, production of a film in the case of ethnographic documentary, development of digital components into robust software systems, or similar activities.

8.3 DivE Activities

As was detailed earlier, the DivE-process consists of three phases, while the main phase is structured as a succession of iterative steps. Iterative steps and phases in turn are composed of individual project *activities*, such as workshops, programming sessions, and field studies. Activities thus describe the individual organisational building blocks out of which a DivE-process is crafted, constituting the most fine-grained unit of reference within the terminology of DivE.

In contradistinction to steps within iterations, multiple activities may be pursued concurrently and may be terminated before completion at the discretion of project participants. Steps can consist of one or many activities, while the organisation

of activities within steps proceeds at the discretion of DivE's participants.

Participants negotiate type, structure, and succession of activities, reaching agreement concerning the future course of action before engaging in respective activities themselves. While dissensus may arise on the levels of theory and interpretation, DivE here aims for relative unanimity regarding the joint structure of the project itself.

Activities themselves can be broadly divided into three categories:

- *Projective* practices generate design ideas, inform expectations regarding artefact performance, and create novel perspectives on situations of use.
- *Constructive* practices create artefacts or change their material structure.
- *Reconstructive* practices observe patterns of use of artefacts, generate data, and aid the formulation of theory.

The following section details some of the activities undertaken within DivE-projects thus far. It aims at providing an account of the scope of activities applicable within DivE while pointing to the respective function of individual activities within the overall process. Consequently, the list provided does not aim to be exhaustive. Many established design methods such as mind mapping, card sorting, or persona creation will not be covered here as their structure is already well known and participants can be assumed to be competent at adopting them to their individual needs. The list thus is provided as a starting point of reference for participants of DivE as well as a means to illustrate the DivE process itself.

8.3.1 ***Projective Activities***

The following sections cover *projective* activities. These generate design ideas, inform expectations regarding artefact performance, and create novel perspectives on situations of use.

8.3.2 Open Scenario Building

Scenario-based design processes are a well known method within HCI[2,3,4] which can productively be integrated into DivE processes.

Open scenario building consists of participants imagining possible situations of use of an artefact and communicate these using a medium of their choosing. This can take the form of written stories, drawings, sketches, sequences of drawings or sketches, slide presentations, oral presentations, or other means of communication. Crucially, a scenario evokes a situation of use in which the artefact already acts.

Specifically, creation of scenarios can serve clarification of goals during the initial phase of the process or the early steps of an iteration. They can be employed as a device for expectation shaping, allowing for imagined and observed patterns to be compared after deployment of the artefact.

[2] John M. Carroll/Mary Beth Rosson: Getting Around the Task-artifact Cycle (1992).

[3] Susanne Bødker: Scenarios in User-Centred Design-Setting the Stage for Reflection and Action (1999).

[4] Mary Beth Rosson/John M. Carroll: Scenario-Based Design (2003).

8.3.3 Artefact Performance

Within an artefact performance session, one or more participants are tasked with performing the role of an artefact within a situation of use. Other project participants play the roles of users or bystanders, thereby evoking the interactional dynamics of the artefact in practice. Artefact performance can comprise a bodily performance, approximating the behaviour of a kinetic artefact through movement in space. Screen based dynamics can be performed through impromptu drawings or by using preproduced signs.

If the artefact in question is digital in nature, subsequent steps of development can be conceived as translating the performers' mental processes into software.

Artefact performance sessions are especially suited for early steps within the project when artefacts themselves have not yet been made. Thus, they would typically be employed within DivE's initial phase or early iterations within the main phase. However, they can provide a helpful perspective even within

later steps of the project: Artefact performance sessions encourage participants to clearly imagine the performance of the artefact, thus providing helpful information towards its description. Respective sessions also allow participants to get a feel of engendered situations. Due to the slightly unorthodox situation of having to embody a non-sentient thing and the resulting dynamic of initial anxiety and jointly overcoming inhibitions, respective sessions can also act as helpful "ice breakers" during early meetings of the project team.

Furthermore, they provide an implicit illustration of the concept of *symmetry* present within DivE's Latourian theoretical framing.

8.3.4 Material Story Telling

Participants tell a story from the point of view of an artefact. They hence describe the world according to the sensorial capabilities of the prospective or existing artefact in question. Artefact actions are described as constrained by the artefact's material limitations in the form of actuators. Narrations furthermore reconstruct the artefact's thinking as constrained by its programming.

This way of story creation helps to clearbox the artefact. It is especially rewarding if conducted by participants only tangentially involved in practices of material artefact creation such as social researchers and ethnographers. It can contribute to the mutual sensitisations described previously, while uncovering potential problems within existing designs. At the same time, it helps to highlight possible interactional dynamics inhering within existing setups.

It furthermore illustrates DivE's theoretical framing by describing actions undertaken by artefacts.

8.3.5 Studio Critique

Sessions can take the form of an adapted form of studio critique. A studio critique session comprises presentation of the

artefact; subsequently participants are invited to offer their critiques. Crucially, the discussion takes place in a situation of physical co-presence with the artefact. It is operational and interpretations and observations can immediately be demonstrated. In the case of unwieldy installations, material parts of the artefact are present within the room as far as circumstances permit.

Crucially, the artefact is able to provide "situational back talk", chiming in, underwriting or contradicting its interpretations. Thus, in line with the Latourian notion of symmetry, the artefact is to be considered as a participant of the ensuing processes of argumentation and discussion.

The practice of studio critique allows for a complicated artefact to be subjected to a complex web of argumentation and interpretation while remaining in a clearly delineated closed setting. Furthermore, the otherwise opaque convictions and goals of project participants are rendered concrete when explicated vis-a-vis an object of critique. The institution of studio critique thus acts both to provide further impulses regarding artefact development, while at the same time facilitating material argumentation and discussion.

8.3.6 ***Constructive Activities***

The following sections describe *constructive* activities. As the name implies, in the course of constructive activities participants create artefacts or change their material structure.

8.3.7 Hackathon

A hackathon presents the opportunity to intensively work on an artefact in an open group setting for a fixed duration of time. During a hackathon, the artefact is presented and discussed within an open space. The usual project team is likely augmented by other participants for the duration of the activity. After initial discussions, the temporary team sets its own goals,

starting to work intensively towards a desired digital-material reconfiguration of the artefact.

A hackathon's situation is unique in that it allows for feedback, interpretations, and comments by users who have not experienced the artefact before, while providing opportunities for users to become digital makers and subsequently alter the digital-material configuration of the artefact.

8.3.8 Co-programming

A co-programming session comprises the activity of two or more participants jointly working on a software artefact in the mode of physical co-presence. Usually, one participant takes an "active" role by creating code for others to witness and comment on. One or more other participants thus become co-programmers, monitoring and conversing with the active partner.

The activity provides a situational frame for discussing questions regarding the process of code creation. It can also be valuable for participants with limited or no knowledge regarding the production of software artefacts. Though respective unskilled co-programmers will not be able to watch out for coding errors or provide technically viable feedback, the process of mutual discussion and explanation can still serve to demystify and illustrate the process of code writing.

8.3.9 Live-Coding Session

During a live-coding session a participant produces or alters a software artefact in a way such that the *effect* of an entered section of code can immediately be perceived by other participants attending the session.

Typically, other participants witness these effects in a situation of physical co-presence that allows for feedback and communication. A typical setup includes one or more projectors showing both the lines of code in question and the altered program's output.

The duration of live-coding sessions is quite variable, ranging from a couple of minutes to hours of intensive experimentation and feedback. The intended purposes of interdisciplinary development do not require code effects to be truly instantaneous, as is the case in many other live-coding applications. Rather, the goal is to provide a feeling for the coupling of code and effect within a communicative setting. Thus, any way of coding that allows for quick survey of its effects is adequate for the purpose.

The activity itself serves to highlight the dimensions of the digital design space in a way accessible to participants unfamiliar with the implications of digital code production.

8.3.10 ***Reconstructive Activities***

The following sections describe *reconstructive* activities. In the course of reconstructive activities, participants observe patterns of artefact use, generate data, and advance the formulation of theory.

The discussion will first distinguish between different forms of engaging with an artefact's performance.

8.3.11 Lab Study

Within a *lab study*, artefacts are deployed in a stable environment under the researchers' control. Researchers aim at creation of a synthetic situation, consciously designed to facilitate observation of practice. Parameters of the situation can be changed at will, in turn effecting or failing to effect changes within observed patterns of practice.

Lab studies can take measures to approximate intended situations of use or, contrarily, create more synthetic situations in an effort to eliminate possible interferences. Videos and other media can be employed in order to set a certain mood for the experience. Instructors can try to provide a backstory; decorations within the lab provide visual context; smells and sounds can evoke feelings, trigger associations, and activate

olfactory memories. All of these measures will not be able to supplant the social and sensory richness provided by an in-the-wild experience but they can help to create a material texture that sustains practices resembling those of actual contexts of use. It is possible to vary these measures, trying to reproduce a series of different situations in order to gain an understanding of the spectrum of possible patterns of use.

Researchers operating within a quantitative research paradigm often pursue a converse strategy, trying to eliminate possible interfering factors: Windowless rooms can isolate against perception of varying weather conditions, neutral white walls reduce the occurrence of associations, a clear guideline for researcher-participant interaction minimises interference through communication.

Lab environments can be sites of both qualitative and quantitative research practice. However, due to methodological goals such as *reliability*, which implies repeatability,[5] they are a natural choice for researchers working within the quantitative paradigm. At the same time, the utility of many qualitative methods, such as ethnography, hinges on observation of in-the-wild behaviour, thus ruling out lab studies.

The form of the artefact itself might favour a lab or in-the-wild environment: Low fidelity prototypes are usually hard to test in a naturalistic fashion: If the prototype application of a smartphone application is made from cardboard, its operation hinges on instructions and feedback provided externally, such as by an experimentator. Studying these low-fi artefacts in-the-wild is usually not possible.

A lab study typically constitutes a less complex, more complicated situation than that envisioned for the artefact in question. In turn, the relationship between observed practices and in-the-wild behaviour is complicated: Inferring patterns of in-the-wild behaviour from lab studies is usually not possible, expectations regarding naturalistic practices generated from lab observation are frequently frustrated.[6,7,8]

[5] Steven N. Goodman/Daniele Fanelli/John P. A. Ioannidis: What Does Research Reproducibility Mean? (2016).

[6] Yvonne Rogers et al.: Why It's Worth the Hassle (2007).

[7] Yvonne Rogers: Interaction Design Gone Wild (2011).

[8] Eva Hornecker/Emma Nicol: What Do Lab-based User Studies Tell Us About In-the-wild Behavior? (2012).

Lab studies can be especially appropriate during early phases of artefact development, when the general feasibility of a novel interaction pattern has to be tested. If a user interface or interaction pattern appears to be too complicated within the calm controlled environment of the laboratory it will likely be even more so within the complex and chaotic situations of everyday life. However, special care has to be taken in order not to prematurely abandon promising design ideas in the face of initial setbacks.[9]

While the study of cultural phenomena lends itself especially well to in-the-wild approaches, as opposed to lab studies, an iterative development style such as DivE's necessitates frequent engagement with situations of use. Lab studies paired with strategies to approximate the conditions of actual contexts of use can offer a sensible compromise in a situation where frequent in-the-wild exploration would incur prohibitive logistical expenditures.

[9] Saul Greenberg/Bill Buxton: Usability Evaluation Considered Harmful (Some of the Time) (2008).

8.3.12 In-the-Wild Study

In contradistinction to the controlled environment of the lab study, *in-the-wild studies* seek to place and observe the artefact within the complex environments of its intended situations of use. This can take the form of temporary installations in public spaces, the handing out of devices to participants in tandem with long-running interview strategies, temporary deployment of information systems within groups or institutions, or any other measure trying to foster and observe a naturalistic pattern of artefact use.

The in-the-wild approach thus calls for deployment of artefacts in a manner that sustains complex practices, as they would unfold without researcher intervention, rather than focusing on how to facilitate observation of said practices. This in turn renders activities of observation and analysis more complex: In-the-wild studies rely on a wide array of practices of data collection, such as participant observation and other ethnographic methods, video analysis, and various interviewing

techniques. Equally complex are techniques aimed at making sense of data collected: Whether employing ethnographic techniques, grounded theory methodology, or discourse analysis, the path from data to theory is not straightforward.[10] It requires the work of interpretation and concept building, necessitates intermediary steps of coding and annotation.

[10] David Silverman: Doing Qualitative Research (2010).

Crucially, in-the-wild studies enable and require different modes of theorising, as application of existing lab-based theories might not adequately relate to observed phenomena within naturalistic contexts.[11] Consequently, practices of in-the-wild theorising typically draw on an extensive body of previous studies from which they seek to abstract. They frequently relate to ethical concerns, and incorporate concepts such as embodiment and situated action.

[11] Yvonne Rogers: Interaction Design Gone Wild (2011).

In-the-wild studies lend themselves especially well to the study of complex cultural processes. The intricate web of sensorial perceptions, social interactions, and participants' expectations towards engaging with cultural phenomena are hard to replicate in a lab setting. Within the context of projects discussed, it was thus adopted as a beneficial model of engaging with practices of use.

However, embracing in-the-wild strategies within an interdisciplinary setting necessitates balancing the interests of those participants whose research practice is indebted to lab-based methods against the benefits of in-the-wild observation. In-the-wild studies might not provide the type of structured data needed for media psychologists or usability engineers to advance their individual, disciplinary framed research practices. Consequently, pursuing a mixed strategy of blending lab and in-the-wild methods presents itself as a pragmatic approach within a multitude of conceivable situations. In any case, both lab and in-the-wild approaches yield specific results not obtainable through the respective other approach and thus contribute to the formulation of non-substitutable theoretical elements. Hence, they should be seen as complementary practices. While respective underlying epistemologies might be at

odds, combining them within an overarching research strategy appears as a viable approach. Reflecting on the specific conditions of results obtained in turn allows for a process of self-aware theory building to emerge.

8.3.13 Exhibition and Demonstration Contexts

During the course of an exhibition or demonstration, an artefact is displayed in a manner that encourages others to consciously relate to it, reflect on it, provide comment and critique. This can take the form of art exhibitions or demonstrations at a conference or trade fair. In the case of multiple interpreters, critique can assume the form of debate, allowing multiple interpretations of an artefact to play out their inner oppositions.

While lab and in-the-wild studies usually focus on practices of use, exhibition contexts pair these with a conscious opposition between participants and artefacts presented. This entails switching between two quite different modes of relating to an artefact, between the mode of conscious reflection and discussion and the mode of using the artefact.

8.3.14 ***Methods for Data Collection & Analysis***

In the following section I will detail some of the methods which can be applied during the course of the DivE process. Methods serve their own specific function and possess their own meaning within the methodologies and disciplinary communities they were appropriated from.

Specifically, the focus is on methods possessing the capacity to produce data.

Every method shapes the kind of data participants can gain from an experience. They are simultaneously productive in while formatting and constricting what can be expected...

8.3.15 Participant Observation

Participant observation is a widespread method for data collection in the fields of HCI,[12] ethnography and grounded the-

[12] Silvia Lindtner/Garnet D. Hertz/Paul Dourish: Emerging Sites of HCI Innovation (2014).

ory methodology.[13] When doing participant observation, researchers temporarily join a group or community they want to study. Subsequently, they try to witness practices within said community from an insider perspective. The resulting first-hand account of relevant phenomena and practices is often given in written form, with other materials and media as supplementary material.

Within DivE, participant observation can be adequate when the practices structured by a complicating material frame unfold around or constitute a (possibly temporary) community or group. Prior to employing the method, expectations regarding the group's actions and communications can be communicated among DivE's participants.

[13] Kathleen Musante/Billie R. DeWalt: Participant Observation (2010).

8.3.16 Open Ended Interviews

Open ended interviews [14] constitute one of the most unconfined forms of interviewing. This interview practice aims at creating an open situation, in which all participating parties are free to shape the communicative process and steer the conversation into directions not previously anticipated. Nevertheless, interviewers typically set a topic of conversation and ask follow-up questions. Questions for this style of interviewing need not be prearranged and if they are, they are of an open nature. Interviewees communicate their experiences, opinions, and beliefs freely without the interviewer trying to impose a specific structure or following a prearranged guideline. Despite their open nature, these types of interviews do require preparation as researchers develop questions and communicative strategies in order to open up fields of discussion, provide conversational ice breakers, and sustain the flow of conversation. Open ended interviews constiute a process of co-construction of beliefs and social norms and draw on a specific set of skills and techniques on the part of interviewers.[15]

Within a DivE process, open ended interviews can be employed in order to develop expectations and identify relevant concepts. They can furthermore, provide valuable impulses for

[14] Considerable terminological variation exists regarding the denomination and discrimination of interview styles. I follow Rapley's (Timothy John Rapley: The art(fulness) of open-ended interviewing [2001]) use of the term „open ended interview".

[15] Timothy John Rapley: The art(fulness) of open-ended interviewing (2001).

the research process by offering fresh perspectives to the research team. This allows for a complicated digital artefact to be framed within a complex set of concepts and narratives. Consequently, a multifaceted construal of respective situations of use becomes possible.

8.3.17 Semi-structured interviews

Semi-structured interviews constitute a more guided form of communication in comparison with their purely open ended counterparts. They usually contain prearranged questions or lists of topics to be covered during the interview process. However, interviewers are free to diverge from the script, to take topical detours and ask questions that were not prepared beforehand. Semi-structured interviews constitute an established method of data collection within grounded theory methodology,[16] whereby the precise style and structure of interviewing can vary according to a process of theoretical sampling.[17]

Semi-structured interviews allow for expectations to enter the interviewing process without preformatting the space of possible responses. Data obtained during a semi-structured interview thus allows for comparing expectations with actual users' experiences and communications.

[16] Rosalind Bluff: Grounded theory (2005).

[17] Barney G Glaser/Anselm L Strauss: The Discovery of Grounded Theory: Strategies for Qualitative Research (1967), pp. 75–76.

8.3.18 Surveys

Surveys are a method for collecting a corpus of identically structured data items from participants.[18] Usually presented as a list of questions, surveys can be conducted using a wide array of media: as printed questionnaires, via web forms, online messengers, or phone. Surveys constitute an especially popular method in the field of quantitative research.[19]

They can be an adequate choice for ascertaining certain quantitative aspects of an artefact's performance (e.g. "How many users are affected in a certain way?"). It must be noted that the practice of surveying in itself contains a strong compli-

[18] Hendrik Müller/Aaron Sedley/Elizabeth Ferrall-Nunge: Survey Research in HCI (2014); A. Ant Ozok: Survey Design and Implementation in HCI (2009).

[19] Robert M. Groves et al.: Survey Methodology (2009).

cating aspect, shaping participant responses to fit the structure of a prearranged document.

8.3.19 Automatic Measurement

The activity of measurement points to any practice aimed at automatic translation of user-artefact interactions into structured data. Examples include automated recording of interaction characteristics, counting the number of users, or eye tracking.

Often, the mechanism of data acquisition will be incorporated into the interactive artefact itself: Sensors within an interactive setup can be used not only to drive the artefact's interactional logic but at the same time feed into a mechanism that records interaction times, performs user detection, and similar functions.

8.3.20 Research Diary

A research diary constitutes a recurrently updated document, providing a continuous account of a researcher's perspective on the process of inquiry in a principled manner.[20] It comprises a set of dated entries, detailing researchers' thoughts, motivations, observations, plans and expectations at the time of writing. Diaries usually rely on the written word, with materials in other media acting as supplementary materials. It helps researchers to keep track of their thoughts and convictions, allowing them to be revisited at a later time. In so doing, diarying helps to shape expectations, thereby facilitating situational back talk. Within the context of DivE, participants might opt for keeping a joint diary or to provide each other access to their individual research diaries.

[20] David Silverman: Doing Qualitative Research (2010), pp. 17 ff.

8.3.21 Situational Mapping Practices

Mapping practices constitute an integral part of sociologist Adele Clarke's postmodern approach to grounded theory methodology for which she coined the term *Situational Analysis*.[21] The methodology itself is briefly described in section

[21] Adele Clarke: Situational analysis (2005).

8.4.3. I will therefore limit myself here to describing practices within DivE related to a specific form of mapping: situational maps.

Situational maps provide an overview of human and non-human actors relevant to a certain situation. They thus provide an interesting starting point for negotiation of a joint vocabulary within a DivE project. Furthermore, visual renegotiation, repositioning, additions and deletions performed jointly or in antagonistic fashion offer considerable promise for a joint research process: They might provide new impulses for discussion, provide a fresh set of signifiers and concepts, allow for novel differences to emerge and new connections to be drawn. Since typically, not every DivE participant will be versed in situational analysis, the exact semantics and methodological provenance will not be known by all and differing construals of maps are likely to ensue. Situational maps here act as *boundary objects*, flexibly linking social and practice-based research.

8.3.22 Philosophical Dialogue

Philosophical dialogues can be construed both as analytic and as theory building practices. A philosophical dialogue constitutes an exchange between two or more individuals touching upon fundamental questions regarding the issue at hand. Within the context of DivE, dialogues focus on the interpretation of artefacts and the discussion of theories developed. The format allows for a joint exploration of concepts formed within practices of theory making, while enabling a reflection on issues pertinent to observed or expected artefact performances.

Unlike the other formats listed, philosophical dialogues do not constitute an established format for empirical research. Due to their inherent complexity, the necessary generality of concepts used, it is hard to methodologically situate them within a traditional research process. With respect to practice-based research, however, philosophical dialogues offer interesting opportunities. They allow participants to situate an artefact within their worldviews and moral coordinate systems, to relate expe-

riences to basic concepts and convictions. The dialogue format can play especially well with a dialectical form of theory building in which seemingly antithetical or antagonistic categories are recombined in a mode of sublation.

8.3.23 Conclusion

The preceding section provides a discussion of possible activities within the practice-based DivE process. As initially stated, this list of activities is by no means complete. Any activity present within existing design methods that can be appropriated to fit the conditions of interdisciplinary iterative development is a promising candidate for appropriation within the methodology. Furthermore, participants might choose to invent their own types of activity or to recombine existing ones in novel ways to produce entirely new forms of joint making. There are many ways of doing DivE.

8.4 Methodological Ecosystem

A DivE project usually operates across disciplinary boundaries, organising practices of participants with diverse backgrounds into a joint process of practice-based research. It thus draws on methods and results situated within respective disciplinary communities in an effort to orchestrate their activities into a productive dynamic of dialogue and cooperation. Its success is thus predicated on understanding the mutual differences and the potential interrelatedness of said approaches and practices.

The field of existing methodologies is vast, however, its description well out of the scope of this document. The current section thus limits itself to pointing towards the amount of variety present within the methodological ecosystem, thereby communicating possible modes of orienting a DivE process towards existing methodologies and approaches.

8.4.1 Ethnography

Ethnography denotes a style of doing qualitative research with a long history of application within the fields of HCI and design.[22] In itself, ethnography does not constitute a single methodology but rather points to a family of similar methodological approaches.

Ethnographic methods have extensively been applied in the field of anthropology in order to provide accounts of complex cultural phenomena. In their "classical" anthropological-ethnological form, ethnographic studies were long-running, as participants submerged themselves within a culture or community marked as foreign within the researcher's perspective. Ethnographic methods have since spread into other areas of inquiry, providing results within fields such as sociology, design,[23] and animal studies.[24] They typically employ participant observation as the key element of data generation, while employing writing techniques[25] in order to organise and interpret results. However, ethnography remains open to other forms of data acquisition, such as interview techniques or collection of artefacts and other physical materials, while its scope has broadened and modes of application have been subject to processes of differentiation.[26]

Ethnographic methods provide an interpretative account of cultural phenomena that is well suited for understanding complex processes. They are especially appropriate whenever research questions involve the practices, attitudes, beliefs, and motivations of a group connected to a created artefact.

[22] Paul Dourish: Implications for Design (2006).

[23] Tony Salvador/Genevieve Bell/Ken Anderson: Design Ethnography (1999).

[24] S. Eben Kirksey/Stefan Helmreich: The Emergence of Multispecies Ethnography (2010).

[25] James Clifford/George E. Marcus: Writing Culture (1986).

[26] Phillip Vannini: Non-representational ethnography (2015); Dhiraj Murthy: Digital Ethnography (2008); Sarah Pink: Doing Sensory Ethnography (2009).

8.4.2 Grounded Theory Methodology

Grounded theory methodology (GTM/GT) is a qualitative research methodology, originally developed by sociologists Barney Glaser and Anselm Strauss.[27] It generates theories *inductively* through gradual development of concepts extracted from engaging with empirical data.

[27] Barney G Glaser/Anselm L Strauss: The Discovery of Grounded Theory: Strategies for Qualitative Research (1967).

Thus, researchers applying GTM develop theories following a *bottom-up strategy*: They intensively analyse qualitative data obtained, trying to identify relevant *codes* within materials such as interview or video transcripts. Codes are collected into *concepts* which in turn are grouped into *categories*. Based on insights generated, researchers formulate tentative theories expressed through categories and concepts developed. During this process, they organise intermediate results in the form of memos which document the theory building process and express partial knowledge.

A GTM process is bootstrapped using an initial research question which prompts the very first instance of data collection. Subsequent steps of collection of new data are guided by tentative theoretical elements previously generated through the inductive process described above. Preliminary theories thus guide the sampling process, as researchers try to saturate their concepts with empirical findings, searching for new data that might enrich or upset the conceptual framework previously generated. The engendered process of data generation stops once new data provides no new insights and no longer causes perturbations within the conceptual apparatus developed. Hence, GTM processes are driven by a „feedback-loop“ between practices of data collection and ongoing practices of analysis. Within GTM, research questions themselves are subject to revision, as a researcher might determine how original questions now longer adequately relate to reconstructed social phenomena.

Due to its iterative structure and the existing interrelationships of developed theory and further data generation, GTM processes are well suited for connection with a DivE project. This alignment between DivE and grounded theory is, in fact, not coincidental. Many researchers within DivE's development context relied heavily on grounded theory for their research practice and had chosen research questions related to those pursued within the practice-based projects that informed DivE's formulation. DivE thus developed in an interdisciplinary ecosys-

tem of research projects that allowed a lively exchange of ideas between practice-based research and sociological grounded theory practice.

Nevertheless, aligning a practice-based research process with a grounded theory project will always remain a challenging endeavour. First, this is due to the long-running nature of GTM processes and the varying length of constitutive steps, which in turn poses a challenge when trying to establish an iterative rhythm for a joint research project. Furthermore, GTM processes are not designed to deliver constructive input regarding artefact creation. Changing an environment through deployment of artefacts is not a typical mode of data generation for the GTM researcher and might in fact violate or contradict some of the basic tenets of adopted modes of data collection. Resultingly, aligning a DivE and GTM process is predicated on a continuous process of mutual methodological sensitisation and ongoing energetic negotiation of participants' goals and research interests.

8.4.3 Situational Analysis

Situational analysis is a specific way of doing grounded theory developed by sociologist Adele Clarke.[28] The methodology seeks to address challenges posed by the postmodern turn in the social sciences, specifically, it aims at doing justice to the instability of everyday phenomena while producing non-reductive accounts of the object of study. It thus conceives of itself as addressing the positionality, relationality, and situationality of both social phenomena and those of the research process through which they are reconstructed. In contradistinction to other postmodern positions, it does not focus on individual subjectivities or expressions of individual positions but aims to provide a methodologically sound reconstruction of social and discursive phenomena that acknowledges their complexity.

[28] Adele Clarke: Situational analysis (2005).

Situational Analysis builds on existing practices of doing GTM, introducing a focus on issues such as embodiment, situatedness, and locality. Arguing that symbolic interactionism has

always already been postmodern, Clarke develops a perspectival epistemological foundation for the methodology.

Regarding actual research practice, three practices of mapping constitute the core of situational analysis: doing situational maps, doing social worlds/arenas maps, and doing positional maps.

At the outset of a project of situational analysis, researchers assemble *situational maps* through identification of every and all human and non-human elements relevant within a certain situation. These are drawn as a map, yielding an initial unstructured visual account of the situation in question. Consequently, situational maps produced during these initial steps of analysis will be messy and might include elements of only tangential relevance.

In fashion similar to regular grounded theory, the analysis proceeds by grouping items on the messy map into categories, thereby producing an ordered version. This activity of grouping is sustained by analytical tools appropriated from GTM and can itself be a complex endeavour, spanning multiple iterative steps within the analytic process.

Once assembled, the main practice enabled by situational maps is that of *relational analysis*: Researchers focus on a single node within the map and systematically reason about its relationship to every other node. The process is repeated for every node within the map and resulting connections are drawn within diagrammatic space, giving rise to a series of relational maps. Thereby, researchers uncover a network of mutual dependencies, which in turn highlight untheorized connections within the data and likely provide novel impulses for data collection and further analysis. Crucially, researchers also take note of the *absence* of expected relationships, thus pointing to what Clarke calls *sites of silence* within the data.

While situational maps give an account of social microdynamics, the second practice of mapping, doing *social worlds/arenas maps*, engages social phenomena at a meso-level: They provide an account of collective entities and their respec-

tive relationships. These collectives comprise human and non-human actors while establishing their respective boundaries through a process of continuous negotiation.

Finally, *positional mapping* seeks to contribute to an analysis of the positions present within discourses of interest (e.g. possible stances on abortion rights, possible priorities regarding emotional work vs. clinical efficiency in health care). Crucially, the practice of positional mapping does not proceed by first identifying collective and individual positions which subsequently are represented graphically. On the contrary, it tries to identify the basic dimensions underlying observed positions that in turn allow representation of individual positions encountered within the respective discursive universe. These identified dimensions are represented graphically (often in the form of two axes within a two-dimensional diagram) and allow positions taken and not taken to be situated within the emerging discursive space.

All forms of analysis discussed above are accompanied and sustained by memoing techniques and guided through the practice of theoretical sampling, as practised during the course of "regular" GTM. They are furthermore embedded into the practices of coding and concept building present within GTM. Consequently, items within maps can be the product of coding and grouping while in turn feeding into processes of theoretical sampling.

Situational Analysis is a fitting methodological candidate for interrelation with a DivE process. It aligns well with the conceptual style adopted in DivE for its emphasis on differences and complexities. Since maps produced contain both human and non-human elements it is in epistemological alignment with respect to DivE's current framing in material-semiotic assemblage theory. The iterative style inherited from GTM allows for a productive interrelation with DivE's rhythm of joint activities. Crucially, maps produced throughout the analysis process offer an accessible way of pointing towards the gradual buildup of theoretical knowledge during the course of a grounded theory

process: If shared among participants the changes within a situational map provide a glimpse of the ongoing work regarding formation of concepts. They thus provide a visual account of the work of aligning empirical data and conceptual apparatus.

8.4.4 Quantitative and Statistical Methods and Methodologies

Quantitative methods constitute one of the main methodological paradigms within HCI evaluation strategies. They lend themselves to a broad set of research strategies, ranging from small heuristic studies involving half a dozen participants, to exhaustive experimental setups on the scale of hundreds of cases.

They can follow a hypothetico-deductive model in which a set of hypotheses are developed and tested in order to ascertain their relative power of prediction. Hypotheses within this paradigm are typically framed using a large body of well established theory in the respective field. Statistical methods of this kind often employ statistical inference, understood as an effort to infer a probability distribution for a population based on an observed distribution reconstructed from a sample of said population. Due to the methodological requirements of sound statistical analysis, studies of this type usually rely on a large number of samples: It is not uncommon for a quantitative study of this type to involve hundreds of participants.

However, researchers within the fields of usability research or human factors are known to relax requirements dictated by sound statistical analysis, instead pursuing more heuristic research strategies.[29] Since results obtained from user studies are used in order to refine designs, a tradeoff between the amount of knowledge generated and the amount of resources spent is usually observed.

[29] Robert A. Virzi: Refining the Test Phase of Usability Evaluation (1992).

As of the time of this writing, DivE has not been extensively evaluated in tandem with statistical methods on a large scale. Since these methods are long-running and typically do not produce new concepts in the course of their application, interrelation with the DivE process is challenging. This problematic is somewhat less severe in the case of longitudinal studies, which

collect new data repeatedly during the course of the research process.

However, experimental designs are often revised in a gradual process employing pre-studies. These preliminary studies are less resource intensive and require less time to set up. Consequently, negotiating a joint set of questions to be tested in the course of pre-studies could be an interesting starting point for setting up a cooperative practice-based process. Furthermore, there is a tradition of conducting *formative* evaluations within the quantitative paradigm.

Ultimately, what type of methodology is employed is for the participants of the DivE process to decide. Should their questions be best addressed using statistical methods while their overarching goals are still amenable to practice-based research there should be no reason for them not to appropriate the DivE methodology. Extensive use of statistical methods would likely necessitate adjustments to the DivE process itself. Specifically, participants could opt for reexamining the role of **Expectation Shaping** and **Situational Back Talk** steps within a DivE iteration. Since quantitative-empirical situational back talk might occur less frequently, one could complement quantitative evaluation through activities of simulation or studio critique.

In any case, researchers versed in quantitative methods do make for interesting participants within a DivE process. Application of quantitative methods is predicated on an ability to translate statements on the level of theory into concrete empirical phenomena which then become subject to testing. This ability of translation is an important skill within the context of DivE. Within quantitative paradigms, these translations usually take the form of framing cultural dynamics within complicated terms.

Furthermore, quantitative methods are an interesting candidate for a *mixed methods* approach in which differing methods are combined in order to develop an account of the phenomenon of interest.[30,31,32] In this respect, approaches that

[30] Jennifer C. Greene/Valerie J. Caracelli/Wendy F. Graham: Toward a Conceptual Framework for Mixed-Method Evaluation Designs (1989).

[31] Margarete Sandelowski: Combining Qualitative and Quantitative Sampling, Data Collection, and Analysis Techniques in Mixed-Method Studies (2000).

[32] R. Burke Johnson/Anthony J. Onwuegbuzie: Mixed Methods Research (2004).

combine quantitative and qualitative methods in a theory-based manner[33] appear to be especially promising.

[33] Hanna Schneider et al.: Understanding the Mechanics of Persuasive System Design (2016).

8.5 DivE's Theoretical Framing

As was noted earlier, operation of the practice-based process is predicated on the existence of a consistent theoretical base. As Scrivener and Mäkelä point out (see 3.2.1; 3.2.3) practice based dynamics can only unfold with support from a consistent theoretical frame.

It is used to impose a structure on dialogue between researchers as well as on the construal of observed practices. Situational back talk is construed to occur both in the context of evaluating constructed artefacts and during argumentation processes among project participants.

While specification of a theoretical framing presented itself as a simple matter of choice in the context of individual projects, it poses a substantial problem in the context of interdisciplinary settings. If consensus on the level of theory is unavailable, an intricate problem presents itself: The methodology requires a shared theoretical framing in order to operate, to produce communicable expectations and frames for interpretation. At the same time, lack of consensus on the level of theoretical framing is among the problems the methodology itself has to address. DivE addresses this problem by inviting participants to discuss a joint theoretical artefact. Consensus is not required, instead all parties are invited to explicate their individual *reading* of the shared theory. The created presence of a shared theoretical point of reference provides terminological cohesion while the possibility of individual readings allows participants to articulate a difference in a manner intelligible to others. The shared theory thus acts as boundary object, while individual readings provide consistency and credibility within disciplinary communities.

In the following, I will discuss a possible theoretical artefact in the form of Latour's theory of material-semiotic assemblages

and the cognate conceptual pairing of complexity and complication.

8.5.1 Complexity

At a foundational level, Latour's complexity / complication distinction (see chapter 2) serves as conceptual boundary object. It is embedded into disciplinary readings of the theory of material-semiotic assemblage.[34,35,36]

Apart from the general function of a joint vocabulary of facilitating situational back talk, complexity/complication allows for discussion of disciplinary translations and thus the *temporal dynamics* of the project.

Activities such as modelling, programming, formalisation perform translations into the domain of the complicated. When working on formal material, optimising algorithms, reorganising software artefacts, or refining formal concepts, informaticians perform *complication reductions*[37].

Successful artefact developments, however, were not observed as processes of linear translation from complexity to complication. Instead, frequent resituations of complicated artefacts proved necessary in order to reveal their operation as material frames. Corresponding activities, such as contextualisation, observation, evaluation, interview techniques can be described as *complexity expansions*.

A triangular schema allows visualisation of translation processes within interdisciplinary technology development processes (fig. 9.3).

The practices of informaticians and social researchers can be illustrated within a visual schema based on a joint reception of theoretical material (see 9.3):

Movements from left to right signify complications, a downward movement following the triangle's right side signifies complication reduction, movements from right to left typify complexity expansions.

[34] Verena Fuchsberger/Martin Murer/Manfred Tscheligi: Materials, Materiality, and Media (2013).

[35] Verena Fuchsberger/Martin Murer/Manfred Tscheligi: Human-computer Non-interaction (2014).

[36] Andreas Bischof/Michael Heidt: Die Verkomplizierung des Komplexen. Latours Unterscheidung "Komplex/Kompliziert" als Perspektive auf die Genese von Kommunikations- und Medientechnologien (2015).

[37] These can be construed in analogy to complexity reduction within classic systems theory.

8.5.2 Practice Theory

The unique way in which Latourian practice theory frames the agency of objects allows participants to treat the role of artefacts and users in an equitable manner. It thus facilitates an overlap between foci on social interaction and preoccupations with the performance of digital artefacts. In this capacity, it provides a vocabulary for communication of shared *expectations* across disciplinary boundaries. These expectations in turn are the precondition for situational "back talk" in the sense identified by Scrivener[38] and Schön.[39] Adoption of the shared framing of Latourian practice theory thus enables an interdisciplinary practice-based process to operate according to Scrivener's second condition of rigour (see 3.2.1).

The account the adopted Latourian theory provides of the role of artefacts is the following: Artefacts created are construed as acting in the capacity of material frames, shaping and facilitating practices. Within the special case of the making of formal or digital artefacts, the constructive process can be construed as concerning itself with the complicated. Furthermore, wherever artefacts serve to shape repeatable patterns of practice, they are part of the complication of the complex, thus serving as *complicating material frames*.

In their capacity to act as frames for practices, thus shaping, modulating, or perturbing them, constructed artefacts allow for productive situational "frame experiments" in the sense of Wakkary.[40] Digital artefacts hence become visible as complicated ingredients within a process of continuous exploration of and experimentation with complex practices.

[38] Steven Scrivener: Reflection in and on Action and Practice in Creative-Production Doctoral Projects in Art and Design (2000), p. 7.

[39] Donald A. Schön: The reflective practitioner (1983).

[40] Ron Wakkary/Marek Hatala: Ec(H)O (2006), p. 70.

8.6 DivE's Relationship to Software Engineering

Development of DivE was informed by existing methodologies in the domain of software engineering (SE) and interaction design. Specifically, agile methods,[41] such as Extreme Programming (XP),[42] or Crystal,[43] can be construed as a particularly productive point of reference: DivE exhibits similarities

[41] Pekka Abrahamsson et al.: Agile software development methods (2002); Alistair Cockburn: Agile software development (2006).

[42] Kent Beck: Embracing Change With Extreme Programming (1999).

[43] Alistair Cockburn: Crystal clear (2004).

regarding the lightweight character of its procedures, its focus on adaptability, and its focus on concrete making processes. It thus parallels the agile emphasis of hands-on experience in contradistinction to the more traditional reliance on extensive preliminary planning and specification efforts. Some of the methods employed, such as pair programming, have directly influenced DivE's development.

At the same time, it has to be stressed that DivE does not constitute a SE method itself. Its scope is not software development, or "programming in the large" but facilitation of interdisciplinary projects containing elements of digital making. As such DivE situates itself on a different level of organisation: it organises and arranges methods which play out within their own disciplinary arenas rather than replacing them with an overarching methodological frame. However, apart from integrating agile elements, DivE was designed in order to be compatible with said methods.

Furthermore, DivE does not describe any procedures imposing a set structure on overall project management. It calls for participants to negotiate these structures themselves while acknowledging the presence of institutional and organisational environments which will often constrict the openness of any process of negotiation.

In relating DivE to SE methods, three levels of analysis are pertinent: the constitutive *hybridity* of DivE projects, the *autonomy* of participants and practices within DivE, and the acknowledgement of constitutive *antagonisms* within the DivE process.

8.6.1 Hybridity

DivE is geared towards projects that combine characteristics of technology research, creative production, and more traditional social science/STS research. Following Holmes' terminology, these can be described as *hybrid projects*. This is in contradistinction to most approaches within SE, which typically focus on creation of artefacts and systems satisfying a set of require-

ments rather than focusing on issues such as expression, social consciousness, and creative knowledge production.

8.6.2 Autonomy

DivE expects participants to be self-motivated entities, pursuing goals of their own, articulating and enacting their own plans, convictions, and agendas. This is different from many SE methodologies, which typically account for a customer/provider relationship. DivE, as such, is not aimed at satisfying a customer or providing a competitive advantage of any kind (though it might do so under certain circumstances).

8.6.3 Antagonism

SE methodologies usually aim at integrating participants within a single methodological framework. DivE is based on the assumption that participants will remain indebted to disciplinary methodologies and perspectives. In fact, DivE's utility derives from the fact of orchestrating said differences with the intention of unlocking and multiplying an inner richness of perspectives.

DivE acts as a further methodological layer in order to fashion a joint project in which individual disciplinary practices will retain their place and utility. On a more conceptual level, the base category of many SE methodologies seems to be identity while DivE's fundamental category is difference. It is not designed in order to integrate participants into a single organisation, set of operating procedures, or epistemological principles. Consequently, participants' motivations, goals, and viewpoints are assumed to be more antagonistic than in typical SE scenarios.

DivE is furthermore based on the assumption that antagonisms described will materialise within artefacts constructed. These are construed as embodying struggle and strife while allowing for diverse and conflicting readings.

8.7 Reconstructing DivE's development

In order to fully understand the relationship between DivE and the practice-based projects discussed within the preceding chapters, it is instructive to consider that DivE itself was subject to a process of gradual development and revision.

As stated earlier, DivE was conceived in order to inform practices of interdisciplinary making. At the outset of its development the conceptual apparatus discussed in chapter 2 was employed in order to analyse practices within the interdisciplinary research network described (see 8.1). This was done in order to create the prerequisites for orchestrating disciplinary activities in a productive manner. Construals provided acted as starting points for participants within DivE's initial phases, while also contributing to a general understanding of the developing methodology itself.

Constructing a methodological base for productively utilising disciplinary differences was approached as a two-step process:

- Developing a conceptual understanding for practices within interdisciplinary development processes. This should allow for description of the specificity of computing practices while allowing communication on the topic of disciplinary difference.

- Development of a tentative methodology, built on the developed conceptual apparatus. This is done in relationship to concrete development experiences.

Identified differences were situated and described in relationship to the conceptual base of complexity and complication. This description of differences served as a common reference point within subsequent discussions.

From the very beginning, DivE was based on the notion that differing viewpoints need not be reconciled on a theoretical level in order to allow for productive making processes. Instead, practices of making in the face of disciplinary difference need to be worked out on a case-by-case basis. If an artefact can be

construed as embodiment of differences, if its development can be driven and invigorated by the interplay of said differences, pacifying them does not present itself as the best conceivable solution.

However, earlier instances of DivE organised differences in a slightly more unidimensional manner, accentuating the division between positivistic/representational perspectives and situational/constructivist/relational ones. Resultingly, it often organised productive frictions along conflict lines stemming from a single perceived difference, such as “representational vs. situational” construals of reality (see 8.3).

Furthermore, earlier instances deployed different groupings of activities. Within earlier stages of the project,[44] I employed a more media-centric categorisation, classifying communicative devices as *visual*, *narrative*, or *performative*. These were gradually reorganised into the present multidimensional system of categories presented above.

[44] Michael Heidt et al.: Diverse Ecologies – Interdisciplinary Development for Cultural Education (2013).

Consequently, any analysis of the relationship between practice-based methodology and concrete practice-based project, has to remain mindful of the fact that it developed within a process of co-evolution, not one of simple application.

8.8 Conclusion

DivE is a methodological framework allowing for processes of artefact centric interdisciplinary construction and interpretation to unfold in the face of antagonistic epistemological and theoretical commitments. Situated within the Practice paradigm while incorporating elements of practice-based research, it structures interdisciplinary efforts of digital making, while in turn being shaped and substantiated by them. Progress and structure of concrete development projects in which the discussed interrelationships have arisen, are described in the preceding chapters.

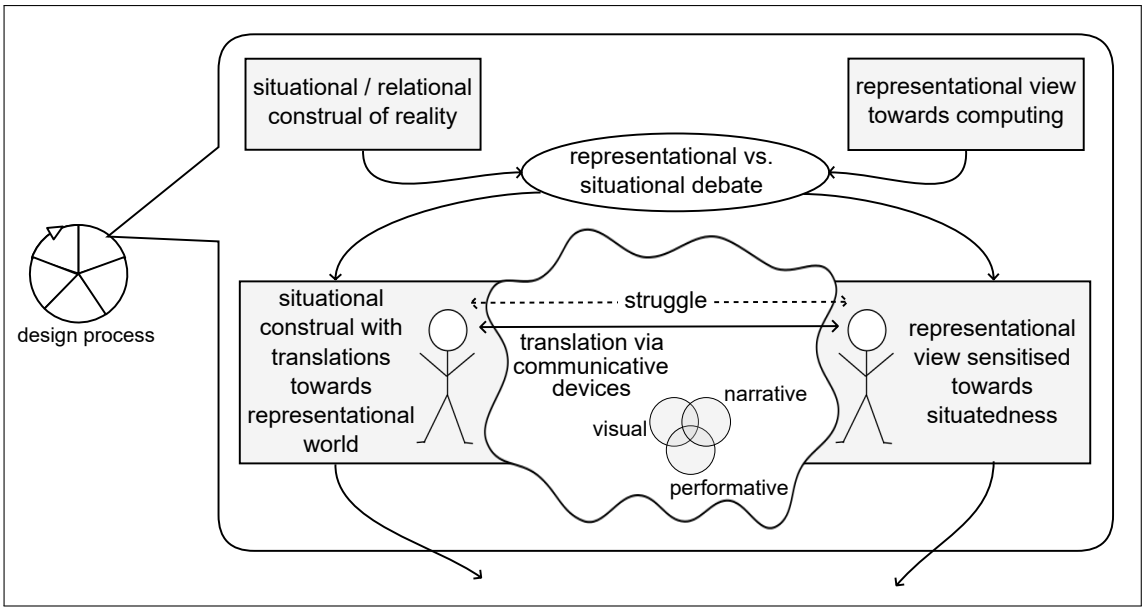


Figure 8.3: DivE Methodology - Frictions Diagram – First appeared in (Michael Heidt et al.: Diverse Ecologies – Interdisciplinary Development for Cultural Education [2013])

9
Results

The research endeavour described in this document can be reconstructed as consisting of two highly interwoven, yet discriminable processes:

i.) Development and refinement of the DivE-methodology for interdisciplinary practice-based research.

ii.) Application of DivE in processes of joint artefact construction, inquiry, and theory production.

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The result of the first strand, the DivE methodology itself, was described in chapter 8. Concrete practice-based projects informed by said methodology have been discussed during the preceding chapters (see chapters 5, 6, 7). On the basis of individual results described earlier, this chapter provides a reflective discussion of the research process as a whole.

The discussion will commence by taking up the second strand, reflecting on the outcome of concrete practice-based projects. Theories and concepts touched upon during preceding practice-based projects are integrated and reflected upon in a synoptic discursive movement (section 9.1). Artefacts constructed and claims made form the basis of an integrative discussion of recurring themes and overarching concepts. Chiefly among these concerns are the topics of digital materiality (section 9.1.1), performance and performativity (section 9.1.2), and the complementary notions of non-use and antiprogramming (section 9.1.3).

Picking up the first strand, I will proceed by reflecting on performance of the DivE-methodology as a whole. Specifically, I will analyse and reflect upon typical patterns and antipatterns of DivE applications (section 9.2.1), and give a brief appraisal and evaluative discussion of the methodology as a whole (section 9.2.2).

Thirdly, both strands are woven together when discussing the question what type of knowledge the DivE-methodology is able to produce (section 9.3). Both the form of DivE's methodological directions and the tangible content of its observed processes have to be taken into account in order to describe the class of knowledge claims enabled through its practice-based processes. The respective discussion will focus on the embodied and material character of observed instances of "doing DivE". Highlighting the intrinsic polyperspectivity of DivE's processes, the text argues for a productive appropriation of the conception of *situated knowledges* in order to relate knowledge claims made and artefacts constructed in the course of practice-based endeavours.

Finally, thesis results are summarised in condensed format, in the form of central claims and hypotheses (section 9.4).

9.1 Project Outcomes: Reflecting Practice-Based Processes and Artefacts

This section details some of the key concepts emerging from description of practice-based projects conducted. I focus here on three aspects: materiality, performativity, and anti-programming.

9.1.1 Materiality

The problematic of materiality presented itself multiple times during processes of material argumentation, in its most pronounced form during prototyping for the ASSMBLG project. Initially triggered by the inability of computing professionals to conceptualise and communicate the relationship between mak-

ing regarding the allegedly intangible dimension of code and making of tangible artefacts, it led to adoption of the concept of *digital materiality*.

Materiality: Digital Materiality

Productively conceiving of the material and the tangible initially posed problems for computer scientists. Accustomed to dealing with supposedly non-material digital and formal entities, our disciplinary vocabularies appear to suffer from a dearth of relevant signifiers. This necessitates and complicates construction of conceptual bridges towards disciplines concerning themselves with construction of physical objects, such as design. Especially during the course of the ASSMBLG project, finding joint descriptions of digital and physical things proved to be challenging.

A conceptual bridge was provided through reception of the theory of *digital materiality*, developed by technology management scholar Paul Leonardi[1,2]. Leonardi provides a view of materiality that deemphasizes the role of physical matter, instead focusing on phenomena of practical instantiation and significance. He thereby, departs from the observation that both the role of objects within processes in organisations as well as the significance of the material of said objects remain undertheorised. Drawing on Pinch's contribution in the field of sociology of technology,[3] the relationship between physical artefacts and conceptual institutions is reexplored. Departing from a semantic analysis, Leonardi bases his discussion on the distinction of material and immaterial reasons or evidence. Following his argumentation, matter can be construed as that what 'matters'. There is no radical difference in status between artefacts occupying the material realm and entities on the levels of discourse, routines or institutions. Consequently, Leonardi's notion of materiality proved to be highly intermateable with the Practice paradigm: Artefacts, whether digital or physical can act as material frames, complicating practice.

[1] Paul M. Leonardi: Digital materiality? (2010).

[2] Paul M. Leonardi/Stephen R. Barley: Materiality and change (2008).

[3] Trevor Pinch: Technology and institutions (2008).

Materiality: Designers as Material

As noted during discussion of ASSMBLG (see 6.7.4), the conception of material was eventually extended in order to comprise human elements within the design process. This was done in the course of a theoretical reframing experiment, and allowed for specification of a vocabulary adequate to the adopted theoretical framing of Actor-Network-Theory.

Materiality: Material Turn within Social Research and HCI

Adoption of the concept of materiality allows for an interesting disciplinary connection as well. A "material turn" can be diagnosed across the disciplines of human-computer interaction[4,5,6] and cultural studies,[7] possibly providing novel impulses for joint practices of theory and artefact making.

[4] Erica Robles/Mikael Wiberg: Texturing the "Material Turn" in Interaction Design (2010).
[5] Shad Gross/Jeffrey Bardzell/Shaowen Bardzell: Structures, Forms, and Stuff (2014).
[6] Tone Bratteteig: A Matter of Digital Materiality (2010).
[7] Dan Hicks: The Material-Cultural Turn (2010).

9.1.2 Performance and Performativity

Theories engaging with phenomena of performativity provided helpful intellectual lenses throughout the course of DivE development and application. Respective concepts were employed in order to analyse user behaviour, understand project dynamics, and create digital interactive prototypes.

It has to be stressed how signifiers such as "performativity", "performance", "performative" are of a multifaceted nature. They point towards diversiform concepts, employed by variegated epistemological communities. This put additional hermeneutical strain on discussion processes within projects. Respective processes of theory reception thus at times oscillate between genuine interpretive gestures and serendipitous productive misunderstanding.

Performativity and artefact use

Theorising performance and performativity allows for analysis and construal of practices of artefact use:

By casting users in the roles of figures of contemporary society, PRMD engages with the problematic of performativity

directly. Resultingly, roles are negotiated within an embodied practice in which human performers, physical objects and digital artefacts engage on an equal footing. The logic of role assignment is inscribed within the digital material of interactive artefacts. Through embodied action, participants can choose to slide into and out of predetermined roles, fluidly negotiating the boundary between performers and audience. Digital devices are not the only elements providing a performative charge. Rather, it is the social presence of a group or crowd of onlookers who texture the experience through their gaze and tacit interactions.

Furthermore, discussion of issues of performance and performativity facilitated new designs and prototypes. Respective readings produced during the course of PRMD in fact enabled construction of PRTL. Within PRTL the complicated material of code itself becomes the subject of performative practices. In this instance, techniques relating to phenomena of performance cultivated during the course of PRMD were reemployed in order to explore the digital material of code itself.

Performance and performativity thus present themselves as crucial conceptual components within a conceptual apparatus tasked with elucidating the role of complicating material frames in the form of interactive digital artefacts. Consequently, analysing phenomena of performance and performativity allowed DivE participants to better understand user and artefact behaviour, while recurrently informing design ideas leading to novel system configurations.

Performativity within DivE

Performance as a phenomenon occurs ubiquitously not only within situations of use but also on the level of interactions within the project team. Roles such as coder, evaluator, social scientist, maker, designer, or engineer impose a set of demands within contexts of development. They require us not only to engage in certain behaviours but suggest and facilitate certain attitudes and self-conceptions. Thus, we are expected

to behave in certain ways and start to expect certain reactions from ourselves.

Fostering awareness of these roles and tacit assumptions allows us to understand each others' performances, question tacit assumptions, and modify or subvert these behaviours we have come to expect from ourselves. Developed theorisations regarding phenomena of performativity thus begin to serve the double purpose of motivating practices of analysis and data collection while simultaneously informing interactions among project participants.

Furthermore, activities such as *artefact performance* within the DivE methodology utilise described effects explicitly by imbuing situations of prototype demonstration with a performative charge.

9.1.3 Non-Use and Antiprogramming

The problematic of non-use constitutes a design concern that surfaced in the course of conducted projects while subsequently demanding additional intellectual input and methodological support[8].

[8] Discussion of the problematic of non-use is based on the publication (Michael Heidt et al.: HCI and the Community of Non-Users [2015]).

The PRMD project pointed to the insight, that within the context of an exhibition visit, binding users' attention to digital artefacts might detract from the complex cultural practices it is purporting to support (see 5.6.2).

During the research process it became apparent that as constructors of digital technology, our responsibility is not limited to organising technology use. There are many situations where technology use as well as technology non-use has to be organised in tandem. Thus, as designers we are responsible for negotiating interleaving patterns of use and non-use.

The discovery of the focus on non-use, initially caused a crisis among computer scientists within interdisciplinary teams. Limiting the attractive power of a digital artefact constructed appeared as alien and counter-intuitive. In addition, no methodology nor adequate language seemed available to a discipline concerned with the *use* of technological elements.

The methodology adopted enabled a concise, theoretically sound description of the problem, while allowing for provision of methods for its solution.

In order to do so, I will develop the notion of an *antiprogram*. The concept, as it is discussed here, is based on early theorisations of Latour and was adopted by Fuchsberger et. al.[9] for the purposes of human-computer interaction.

Latour introduces the concept in *Technology Is Society Made Durable*[10] as an analytic device. A program is a specific pattern of action. Program and antiprogram entail conflicting patterns. Within the ensuing negotiation between program and antiprogram, an effective pattern is realised. Depending on the strength of statements in favour of each, the effective outcome leans more towards program or antiprogram.

The example Latour provides is that of a hotel manager who wishes his guests to leave their room keys at the front desk: Guests' programs do not involve the front desk at all, instead calling for carrying the key at their person when leaving the hotel. The manager's program calls for every guest to drop off their key at every instance of leaving the hotel. Program (leaving keys) and antiprogram (carrying keys at all times) are in disagreement, specifying differing patterns of use and non-use.

Initially, the program remains impotent, and thus the antiprogram's pattern is realised: Guests take their keys with them, whenever they leave. In order to bolster the persuasive power of the program, the initial statement of the manager "Leave your keys at the front desk!" is substantiated through addition of material elements. Elements are added to the situation in the form of repeated verbal injunctions, written signs, and ultimately a weight added to the keys themselves. In this case of a weight attached to a hotel key, the manager's statement becomes loaded with the weight's material. As more elements are added to the situation, a differing pattern results from interplay between program and antiprogram. More customers are persuaded to leave their key at the front desk, the antiprogram

[9] Verena Fuchsberger/Martin Murer/Manfred Tscheligi: Human-computer Non-interaction (2014).

[10] Bruno Latour: Technology Is Society Made Durable (1990).

becomes less powerful, the resulting situation leans more in the direction of the program.

In order to contextualise Latourian notions in relation to the problematic of technology use, the text will proceed by supplying a minimal example of the program/antiprogram terminology.

Example: Smartphone Non-Use

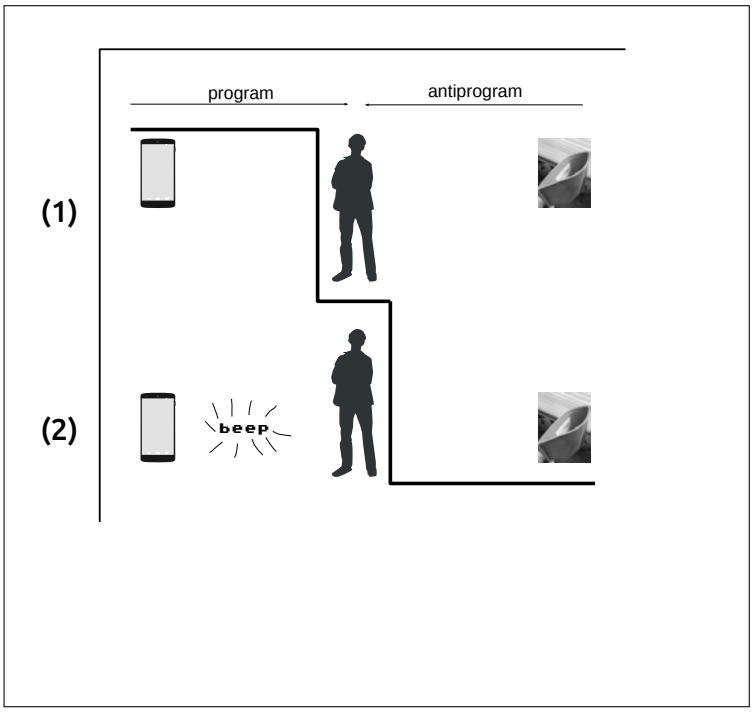

Figure 9.1: Programs and Antiprograms: Smartphone and Smarphone-Case

Smartphones accompany most of their users every day, intermittently being used and put away. Within the conceptual frame outlined, this dynamic has to be framed within the language of programs and antiprograms. In order for the patterns of intermittent use and non-use of the smartphone as an artefact to be expressed, an antiprogram for the smartphone's program of use has to be present. An antiprogram might be supplied by a leather case, designed to accommodate the phone.

We thus are left with two conflicting programs, the touchscreen's program of binding fingers as well as the case's program of containing the phone, breaking the connection between touchscreen and skin. Both cannot be active at the same time.

An analogous case is that of a laptop computer and an accompanying bag.

The dynamic resulting from smartphone-bound program and case-bound antiprogram is depicted in figure 9.1. Following Fuchsberger et. al.'s approach, Latour's original mode of visual presentation[11] is adapted: The diagram is divided into multiple rows, denoting different stages within the negotiation between program and antiprogram. Within every row, elements operating in favour of the program are drawn on the left, while elements operating in favour of the antiprogram are drawn on the right. Subjects of both programs are drawn in the middle of the diagram. A dividing black line delimits elements adhering to the pattern of program and antiprogram. Actors left of the line adhere to the program, actors right of the line adhere to the antiprogram.

[11] Bruno Latour: Technology Is Society Made Durable (1990).

Within the adopted example of smartphone use, the analysis deals with a single user and the possible patterns of use and non use. In situation (1) the smartphone remains within its case, the antiprogram being more successful than the program. Adding an auditive signal to the smartphone's statement strengthens the program in a manner prompting the power dynamics within the controversy to shift (2). The dividing line consequently crosses the human body, turning the previous non-user into user.

Non-Use in the case of PRMD

The installation consists of a projection screen, situated next to an interactive zone tracked via motion sensors. The interaction area is marked by red carpets, thereby directing users' movements. Interaction dynamics proved to be based on the interplay between active users of the artefact and what was perceived as an audience, watching users perform on the stage. Hence, in order to sustain its mode of operation, the artefact has to produce performers as well as bystanders. A corresponding analysis of the artefact is outlined in (figure 9.2).

Crucially, in order to engender practices of discussion directed at the subject matter, patterns of use had to be limited temporally. There seemed to be a strong preference for a pattern of continued use (program) of the system. Complicated digital components are specified in order to provide a short experience of biographical narrative, thus arguing in favour of an antiprogram. Addition of the exhibition stand (fig. 5.15) further adds to the persuasiveness of said antiprogram, “peeling off” participants after they completed the performance. In effect, within the process of negotiation of program and antiprogram, a pattern of short-use emerges, which indeed was the desired outcome. Further work is needed in order to more adequatey represent temporal dynamics within the adopted form of diagramming.

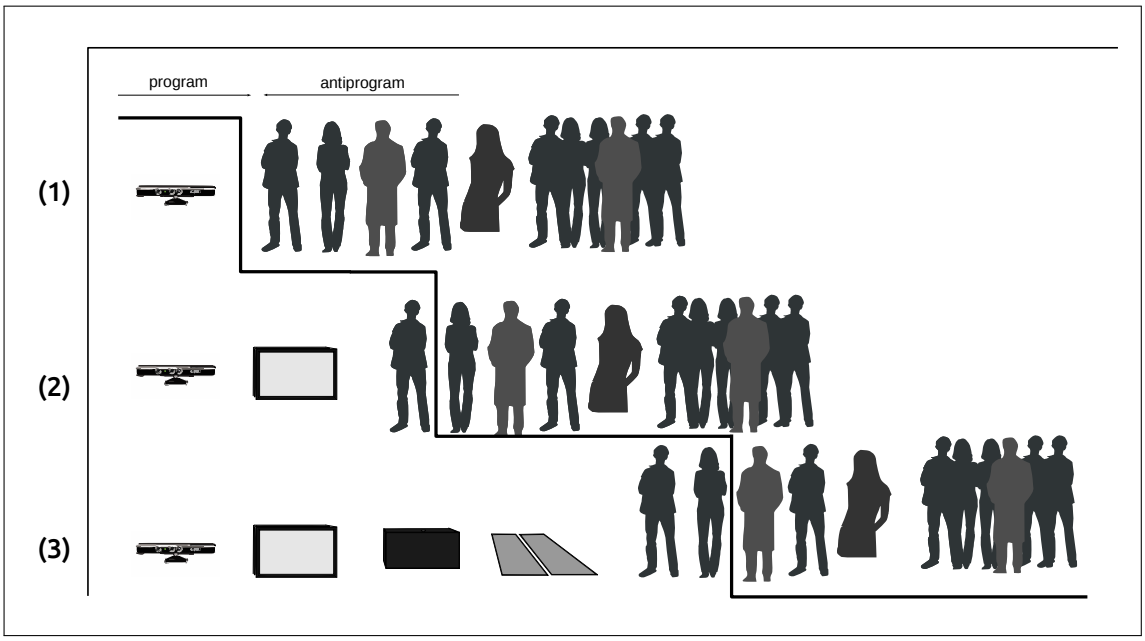

Figure 9.2: Programs and Antiprograms: PRMD

Non-Use: Methodological Appraisal

Non-use as an important feature of user behaviour and as salient design concern was identified in the course of practice-based research processes. It was addressed on a theoretical and methodological level through adoption of the Latourian no-

tion of the *antiprogram*. By doing so, designer's intentions and observed behaviours become elements within a conceptual framework that not only allows to relate them, but puts them on an equal footing. Respective practices of diagramming helped to highlight the initially intangible phenomenon of non-use in a visual manner. Latour's conception thus proved suitable for theorising design of interactive digital artefacts.

Realising the importance of antiprogramming led to a reconstrual of the role of digital artefact creators: They are the makers of complicated digital systems, while at the same time tasked with limiting and modulating the power of attraction of said systems in favour of encompassing complex practices.

9.2 DivE: Reflecting Methodological Performance

This section seeks to reflect on the performance of DivE as a method for supporting interdisciplinary practice-based endeavours. The analysis is supported by observations made during projects described within preceding chapters.

9.2.1 DivE-Methodology: Patterns and Anti-Patterns

Within making projects conducted, specific patterns of cooperation could be observed. These were initially hard to describe in a way accessible to both computer scientists and social researchers. Drawing on the conceptual framing of *complexity/complication*, these patterns could be framed in a way facilitating interdisciplinary coordination. They could furthermore be described through visual means, thus aiding the communicative process.

Anti-Pattern: Complexity Elimination

Computer scientists (both I and other participants) frequently eschewed cultural complexity, trying to delegate dealing with the domain of the cultural to cooperating social researchers. These would be tasked with translating complex cultural pro-

cesses into complicated models and requirements. Resulting workflows call for social research to create formal models for the domain, thus transforming the complex phenomenon into a complicated system. According to this thinking, the computer-scientist's (or system designer's) work proper begins as soon as desired system behaviour is known and has been described as set of complicated relationships within the target domain. She then reduces system complication, seeking the simplest rule system producing desired system behaviours. The envisioned mode of cooperation can be described as one of *complexity elimination* (see fig. 9.3). It is based on the assumption that, for any phenomenon, a separation into formalisable variables is possible. As experts in the field of HCI have noted,[12] this mode of cooperation is far from ideal.

[12] Paul Dourish: Implications for Design (2006).

Complexity Zig-Zag

Joint description of the pattern of complexity elimination allowed for formulation of a methodological remedy: The antagonism between the ultimate irreducibility of complexity and the unavoidable necessity of creating complications is resolved through temporalisation in the context of an iterative process. Participants realise that translations into the realm of the complicated are a prerequisite for production of digital artefacts. At the same time, they have to become mindful of the characteristic reductiveness inhering within acts of complication. A further insight consists of the observation how created digital material frames might cause unintended effects, once they are employed within complex environments. Resultingly, complications have to be recognised as integral part of each iteration, while their effects can only be observed and analysed within rich complex environments.

Instead of resorting to complexity elimination, development processes can hence unfold in an iterative manner: Social researchers generate structured descriptions of complex cultural processes, thereby providing translations towards the realm of the complicated. Developers create complicated material

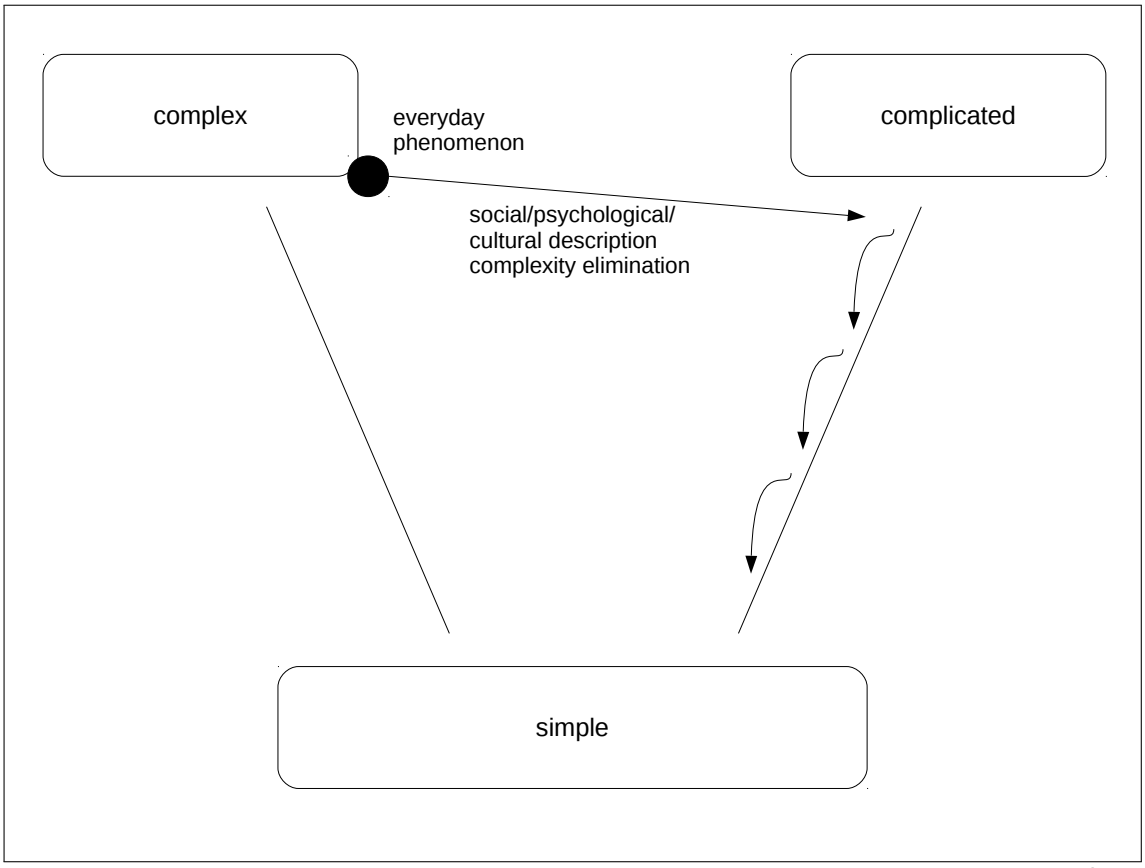

Figure 9.3: Anti-Pattern: Complexity Elimination

frames, which are then reintroduced into complex cultural practices. Through employing complicated procedures, researchers provide an account of this complexity allowing for creation of a simpler version of the material frame. Proceeding iteratively in this fashion creates a sequence of material frames that eventually possesses *requisite simplicity* within situations of use. The interpretorial “surplus” generated through social research methods is thus not lost, becoming accessible as an asset within a project of joint making. The resulting dynamic of continuous negotiation effects a back-and-forth movement between complexity and complication (see fig. 9.4).

These methodological decisions imply an updated conception of the intellectual and poietic division of labour within joint processes of interdisciplinary making. Computer scientists are not only responsible for dealing with complicated systems.

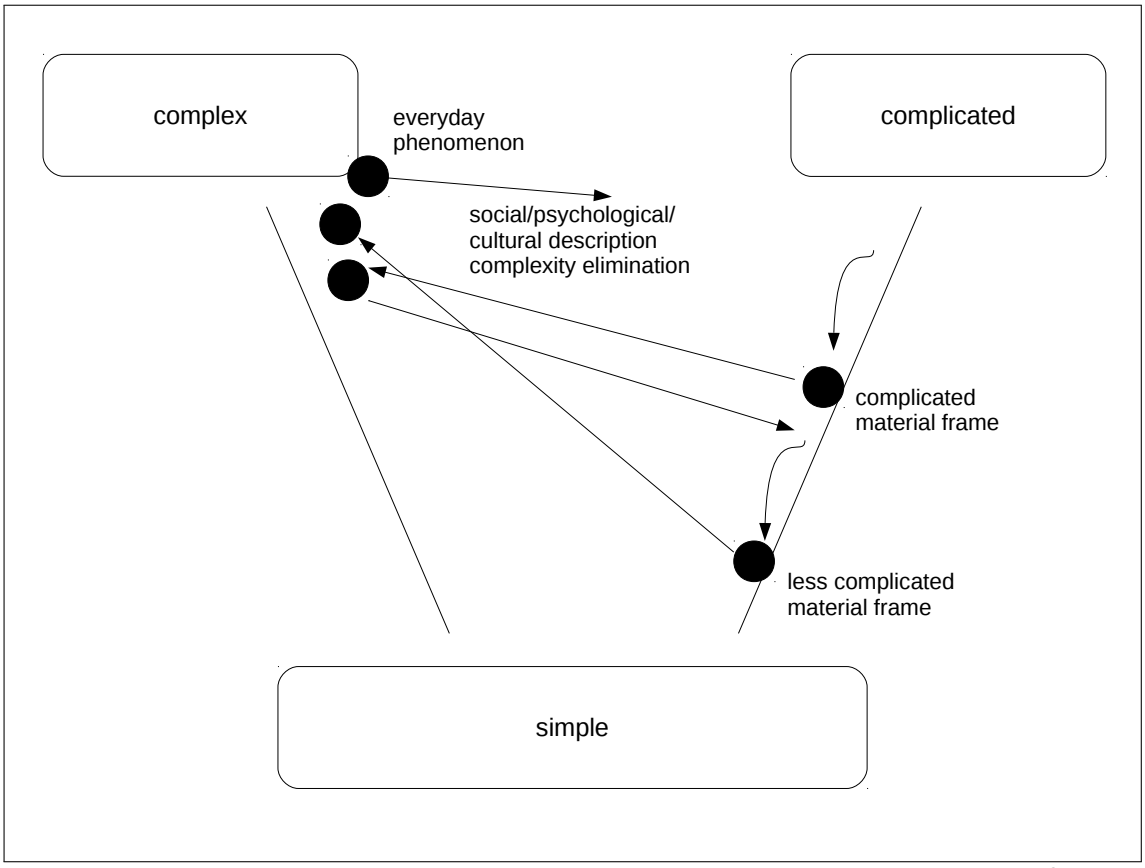

Figure 9.4: Pattern: Complexity Zig-Zag

They also need to keep in mind how these complicated artefacts can be constructed in a way sensibly furthering complex practices. This is not a mere matter of post-hoc evaluations, since adequate expectations of complexity have to be cultivated in order to enable artefact design and the crucial dimension of situational back talk. Cooperating “specialists for complexity” cannot be left alone with these tasks for they do not possess adequate knowledge regarding the modes of construction for complicated artefacts.

This forces us, as computer scientists, to acknowledge and engage the dimension of complexity, without premature retranslations into complicated schematisms. This necessity arises on a *practical level*, when jointly constructing digital artefacts. In addition, computer scientists are not alone with their concern for the complicated. Social research as well, through the

imposition of structure on complex data, employs acts of complication.

Complexity of Computer Science Practices

Finally, computer science practice in itself is complex, as the following observations will illustrate.

Code and coding situate themselves as multifaceted phenomena of mediation within the complexity-complication continuum. Initially, coding appeared as the complicating practice par excellance, since its outcome consists of highly complicated structures. Accounting for practices of coding in the context of interdisciplinary communication, however, proved challenging within practice-based contexts. In fact, no characterisation of coding processes seemed available that were able to inform practice-based processes. It was only through constant negotiations and practice-based inquiry that more elucidative characterisations gradually emerged.

Especially the PRTL project served to differentiate, develop and clarify the status of code and coding. Theories from the fields of philosophy, literary studies and science and technology studies were used in order to situate and interpret the phenomenon of code. Drawing on informatician Christiane Floyd's writings,[13] software construction became theorisable as a mode of world-making. Furthermore, adoption of Grounded-Theory-Methodology led to the reception of Engelmeier's accounts of software construction as implicated in a network of activities of text interpretation.[14]

[13] Christiane Floyd: Software Development as Reality Construction (1992).

[14] Gregor Engelmeier: Grounded Theory und Systemanalyse in der Informatik (1994).

The aforementioned reframings facilitated a novel reading of the practice of code-making: Computer science provides more of a *complicated reading* of the texts it itself produces, focusing on inner-structure and formal semantics. Social research practice produces more of a *complex reading*, focusing on the potentials of embedding the complicated text into complex cultural practices. At the same time, social research inquires into the complex conditions of source-code production, by describing coding practice, processes of cooperation

and translation, with its complex procedures, misunderstandings and subtle semantic shifts. In line with the "back-and-forth" pattern described above, coding itself emerges as a practice deeply embedded within networks of interdisciplinary communication, continuously translating between the complicated and the complex. Produced by complex practice while making up the building blocks of complicated systems, the phenomenon of code emerges as mediator between both worlds.

Based on the aforementioned conceptual developments, analysis of coding as practice served as platform for description of culturally complex phenomena. Gender difference became theorisable by relating code and semiotic theory[15,16]. The political implications of code and coding could be approached through combined readings of cognitive science theory and Rancierean philosophy[17,18]. This productive combination of antagonistic epistemological commitments was facilitated through the conceptual framework provided by the complexity/complication distinction.

[15] Michael Heidt et al.: Incommensurable Writings - Examining the Status of Gender Difference Within HCI Coding Practices (2015).

[16] Michael Mateas: Semiotic Considerations in an Artificial Intelligence-Based Art Practice (2003).

[17] Vicki Moulder/Michael Heidt/Lorna Boschman: Transcoding the Aesthetics of Activism (2015).

[18] Michael Heidt/Vicki Moulder: The Aesthetics of Activism (2015).

Epistemic Complexity and Cross-Epistemological Design

The concept of complexity allows to account for disciplinary differences as well:

Disciplinary communities frame their actions within their own vocabularies and epistemologies, employ their own criteria and practices.[19,20,21] If we accept this premise, effective orchestration of disciplinary differences within development projects requires adequate construal of individual practices and epistemological framings. Devices such as DivE's iterative structure constitute elements of complication, imposing a set temporal order on construction processes while enforcing expectable patterns on the negotiation of disciplinary difference. DivE's practices can thus be read as an effort to orchestrate and complicate the complexities inhering within interdisciplinary practice-based work.

[19] Andrew Barry/Georgina Born/Gisa Weszkalnys: Logics of Interdisciplinarity (2008).

[20] Mike Metcalfe: Generalisation (2005).

[21] Alan Blackwell et al.: Creating Value Across Boundaries: Maximizing the Return From Interdisciplinary Innovation (2010).

The developed framework thus can be read as an extension of Wakkary's approach towards complexity,[22] through adoption

[22] Ron Wakkary: Framing complexity, design and experience (2005).

of the complexity/complication distinction.

9.2.2 Appraisal of DivE

On the basis of individual project outcomes, this section provides a brief appraisal of the DivE methodology and its constituent parts.

Since the methodology has been derived from and applied to successfully conducted practice-based projects, it can reasonably be ascribed a certain degree of viability. However, due to the specific processual and self-referential character of practice-based research, assessing its degree of success is no simple matter. Since it was simultaneously derived from and applied to interactional patterns reconstructed from said projects, it necessarily fits the needs of the projects in question. Goals and criteria are negotiated among project participants and subject to change during the project itself, which in turn complicates assessing the success of individual projects.

Due to these intricacies, I do not believe a final conclusive appraisal of the methodology to be possible at this stage of its development. Possible modes of appraising the methodology could consist in conducting a principled qualitative evaluation of DivE projects by researchers versed in interaction design, critical technical practice, and technology development.

In the following, I present observations and hypotheses that might prove valuable in conducting an appraisal of this kind.

Appraising DivE: General Appraisal

The methodological framework itself was validated and updated through its successful application in the course of concrete interdisciplinary making projects. Adoption of the notion of *hybrid-projects* allowed for a prototyping process that embraces goal-oriented modes of thinking, while encompassing concerns with cultural meaning and relevancy addressed through adoption of practice-based elements. Following the practice-based paradigm, artefacts produced, in tandem with interpretations they engender, constitute research outcomes of respective

studies. Individual concerns and theories were already discussed in the context of respective studies.

Appraising DivE: The LOOPHOLE Prototyping Architecture

The architecture allowed for rapid construction of prototypes of varying degrees of complication.

Regarding systems design, the concern of creating an architecture that remains accessible and transparent to project participants with lower technological literacies is advisable. Specifically, regarding prototyping architectures, it can be advisable to create an architecture, in which layering is less strictly enforced than expedient from a more purist technology-oriented perspective.

In the context of the discussed project, it was possible for designers to manipulate computations and data structures on the level of the `Javascript`-based presentation layer which belong to the area of business logic. This is incorrect from an architectural perspective, for respective alterations impinge on application layer performance. However, this mode of operation allowed designers to experiment with the layer of the system they felt most comfortable with. Non-strict enforcing of layering proved adequate within concrete development contexts.

Due to the iterative nature of the development process, changes introduced on the “wrong” layer did not pose a problem to the technical integrity of the system. They are moved to the correct layer within the next iteration of the joint making process.

Appraising DivE: Complexity, Complication, and Actor-Network-Theory

The theoretical framing comprising a reading of Actor-Network-Theory as practice theory, boundary objects, and the complexity/complication distinction proved adequate for sustaining interdisciplinary processes of digital making. They allowed a productive framing of disciplinary differences in the form demanded by the adopted methodology.

Appraising DivE: Digital Artefacts as Boundary Objects

The notion of *digital materiality* enabled computer science artefacts to act in the capacity of boundary objects within practice-based interdisciplinary projects. Special methodological attention is necessary to provide theoretical and methodological translations, while future challenges remain (see 9.2.3).

Appraising DivE: Methodological Limitations

Additional experiences are needed in order to provide a more fully developed account of the potentials inhering within the DivE methodology.

The preceding discussion of the DivE process is written from the perspective of the main developer of the methods employed. Conducting a comprehensive study of a DivE process from a social science perspective would be instructive indeed.

The DivE methodology demands engagement from participants. As such it is not adequate for interfacing with research methodologies that require a high amount of distance between social science and computer science.

So far, DivE has been used to construct systems exhibiting modest technical complication. It remains to be seen what bearing construction of more complicated artefacts would have on the method.

9.2.3 DivE: Methodological Extensions and Future Directions

Methodological Directions: Qualitative Methodology and Source Code

Throughout the interdisciplinary making processes, a glaring omission within the set of qualitative research methods became visible – few, or no methods seemed available for dealing with source-code. Although interested in nearly every aspect of everyday life, professional conduct, or workplace layout, surprisingly little methodological support was available to a social researcher dealing with this complicated object.[23]

This omission is particularly severe in the context of a practice-based approach that heavily relies on creation of digital arte-

[23] Michael Heidt: Reconstructing Coding Practice - Towards a Methodology for Source-Code (2013).

facts. Many layers of the made object remain inaccessible to discussion with social researchers, since no mode of sound methodological treatment is available.

Practical methodologies allowing for tighter integration and a more direct dialogue of digital making practice and social theory building processes might be developed by accounting for structural similarities between informatics theory building processes and certain forms of qualitative social research.

A promising candidate for specification of adequate methods is the approach of Engelmeier,[24] combining the methodology of *grounded theory* with informatics systems analysis activities. The position conceives of both processes as part of a joint activity of *text interpretation*. It thus can be situated within the theoretical vocabulary of *textualism*, identified previously (see 2.3). A situation within the framing of practice theory thus calls for further translations from textualism into the language of practices. Also, an interesting connection exists to social science theories formulating concepts of code literacy.[25]

[24] Gregor Engelmeier: Grounded Theory und Systemanalyse in der Informatik (1994).

[25] Stephan Dreyer/Nele Heise/Katharina Johnsen: „Code as Code Can". Warum Die Online-Gesellschaft Einer Digitalen Staatsbürgerkunde Bedarf (2014).

Methodological Directions: Computers as Theatre

On the immediate level of methods, appropriation of "flying wedge" diagrams[26] could prove expedient. In the context of PRMD, the observed patterns of anxiety, expectation, and delight observed during usage of the installation could be visualised in this manner. The exact mode of the visualisation process and methodological implications of integration of Laurel's approach are subject of ongoing exploration and future work.

Furthermore, building on Laurel's focus on action, a novel way of relating Latourian practice theory becomes conceivable. If we accept the Latourian premise, that non-human artefacts possess the capacity to act, Laurel's focus on action can be construed to extend to artefacts' actions as well.

[26] Brenda Laurel: Computers as Theatre, Second Edition (2013), pp. 84–87.

Methodological Directions: Performance and Complexity

Additional theorisations are conceivable as well and demand future work: A possible connection to systems theoretic construals of complexity is possible via a theoretical framework developed by theatrologist Erika Fischer-Lichte:[27] Performativity is conceptualised via recourse to Maturana and Varela's notion of the feedback loop.[28] Thereby it is not construed in relation to a text, it is not a translation or a performance of a preexisting sign system. Instead, performance arises dynamically, in a process of continuous mutual interference, between performers, audience, and textual elements. This dynamic way of constructing the concept of performance allows for the notions of performance and materiality to be negotiated within a single theoretical framework.[29]

[27] Erika Fischer-Lichte: The transformative power of performance (2008).

[28] Humberto R. Maturana/Francisco J. Varela: The tree of knowledge (1987).

[29] Erika Fischer-Lichte: The transformative power of performance (2008), pp. 75–137.

9.3 Knowledge within DivE

In order to give an account of the status of DivE as a device for practice-based research, we must describe the specific nature of knowledge produced during its processes. The current section thus simultaneously tries to interpret DivE's performance while detailing its intended mode of operation.

It has to be stressed that the following statements and assessments have to be read as empirically informed hypotheses, not as confirmed facts. Any attempt to provide an exact description of DivE's knowledge-generating capacity will be fraught with complications due to its practice-based nature. Specifically, both the process of incremental development of the methodology during projects described and its inherent interpretive openness complicate any attempt of providing a definite answer regarding the status of produced communications and artefacts. At the same time, it remains important to provide a reflexive account of the status of knowledge generated in order to understand the methodology's operation, to communicate it to others, and to allow an accurate judgement of its outcomes.

Interdisciplinary Knowledge as Aggregate

A DivE process organises, combines, and appropriates practices already serving an epistemological function within their particular disciplinary communities. Consequently, respective disciplinary procedures generate knowledge according to the boundaries of these preexistent standards.

Ethnographic practice produces thick descriptions of cultural phenomena, grounded theory produces concepts saturated with empirical knowledge which are self-reflexively differentiated against its domains of observation. Computer science gives an account of how it skillfully assembles complicated structures, of how it balances their possible behaviours against requirements, facilitates use-cases and adds system-features over time. It describes how to construct complicated formal systems and details how their external behaviour relates to internal rule-based structures. Media psychology and usability testing educate us on the relationship between requisite variables and processes of interaction, providing measures, numerical data, plots and diagrams, backing up claims by virtue of statistical procedures and models. Situational analysis gives us maps and theories attesting to the instabilities, complexities, antagonisms and partialities within systems of practice we previously conceived of as stable.

At first glance what DivE might facilitate is a certain synoptic synthesis of perspectives: Ethnographers' descriptions provide us with detail a solely informatics-based requirements elicitation process might miss. Media psychology supplies the experimental experience and statistical acumen to adequately analyse complex networks of relationships between variables that might be misjudged within the more methodologically lenient practices of HCI evaluation. Computer science provides a constructive perspective that none of the others disciplines are able to supply.

Following this interpretation, the result of the cooperative dynamics would consist in a multifaceted structure of disciplinary framed knowledge claims, existing in parallel. This is without

doubt one of the outcomes of DivE processes and probably an outcome of most truly interdisciplinary endeavours.

Incongruous Frames of Reference

The possible relationship between these disparate claims, however, does not immediately become clear. Due to their differing disciplinary provenance, they seem to exist isolated from each other. Any truly synoptic description of relevant situations depends on the capacity to relate, combine, and judge individual communications. It thus is predicated on a corresponding subject position able to understand and value every disciplinary claim not only in relation to its respective frame of reference but to an overarching perspective spanning across disciplinary divisions.

In effect, this would construct an ostensibly neutral “master position” capable of relegating every other claim and position to a determined position within an overarching order of knowledge. Within the contexts analysed no such meta-position seems to be available. Any claim and communication was subject to practices of reconstruction and interpretation which related them to particular epistemologies and disciplinary practice. The same applies to an integration of mentioned reflective theories, systems of propositions, and complicated artefacts within one coherent body of knowledge.

If we set aside the possibility of an integrated perspective, however, this poses the question, if processes within DivE simply assemble particular knowledge claims, or if their execution creates knowledge apart from what is already present within respective disciplinary framings.

DivE’s Mode of Operation

In order to answer this question, it is necessary to recall the specific ways in which DivE facilitates interdisciplinary communication: DivE was conceived in order to enable constructive action by computer scientists, social researchers, and design-

ers in the face of discipliniary differences. To understand what kind of knowledge the methodology can and cannot produce we have to analyse the specific way it structures these differences.

First of all, DivE organises these differences but it also escalates them. It puts positions into dialogue and reduces the amount of terminological isolation between disciplinary communities. As misunderstanding gradually gives way to genuine difference of opinion to steadfast opposition, conflicts are likely to intensify, not subside. Resultingly, participants are more likely to realise the uniqueness of each other's perspective than develop an integrated view composed of individual knowledge claims. Constant confrontation in tandem with joint building efforts and continuous translations encourage assuming each other's perspectives without erasing disciplinary identities.

As a result, participants within DivE find themselves confronted with objects that they cannot fully account for within the familiar terms of respective disciplinary communities. Social researchers cannot describe the complicated structures underlying information systems under study; informaticians lack the language to describe the complex patterns of use in which complicated artefacts operate.

In light of these observations it might appear that what DivE produces is merely a conglomerate of disciplinary backed claims and particular observations, assessments, and analyses held together by the exigencies of project parameters. Every individual perspective appears to be partial and limited, while the methodology accentuates differences instead of paving the way for conciliatory synthesis.

I will argue here that it is in fact the described realisation of the constitutive incompleteness of one's own perspective that marks the beginning of a joint knowledge-making process. In so doing the present text seeks to mobilise Donna Haraway's concept of *situated knowledges* in order to arrive at a productive account of knowledge practices within DivE.

Haraway's Conception of Situated Knowledges

In her seminal text *Situated Knowledges*[30] Haraway argues for a positional and embodied construal of objective knowledge which is inherently polyperspectival in nature. In a double-pronged intellectual move, Haraway seeks to differentiate her concept both against relativism and against construals of objective knowledge disavowing its embodied characteristics.

[30] Donna Haraway: Situated Knowledges (1988).

Her text sharply criticises dominant construals of objectivity which construct objects as existing irrespective of particular perspectives and positions. In turn, the truth values of claims to objectivity become unbound to any frame of reference, they are allowed to assert themselves as "simply" and unconditionally true or false. Haraway argues how these claims in effect totalise discourse, thereby dressing its objects in a fashion that facilitates control by a disavowed set of actors. These totalisations entail an erasure of heterogeneous accounts of the object in question, effectively silencing all divergent ways of looking at and speaking about it. The text goes on to show how this conception of objectivity serves to hide the position and particularity of a set of master-actors. Invisibility is conferred on a privileged perspective which subsequently gains the ability to conceal itself and articulate its claims as objective.

Crucially, Haraway's criticism is not aimed chiefly at practices of knowledge generation within the natural sciences or mathematics. Rather, it is certain selective appropriations at the intersection of engineering and natural science that produce the totalising power effects against which the notion of situated knowledges is developed.

In contradistinction to this criticised conception of objectivity, Haraway develops the notion of objective knowledge as situated. Within the paradigm of situated knowledges, objects emerge as result of embodied practice, are seen, differentiated, and described by particular actors. As such, objects of study are not inocuous pre-existing entities but are always also effects of processes of material discussion. Objects have to be understood in relationship to the bodies and embodied prac-

tices which produce them. A multitude of practices of perceiving exist in parallel, bodies affected by objects are diversiform and thus exhibit variegated modes of sensibility.

Crucially, multiple actors and communities of seeing and perceiving work together or work against each other to produce objects to which any claim of knowledge relates. Thus, objects are "boundary projects",[31] called into being through construction and contestation. Objectivity thus is the result of "situated conversation",[32] in which actors accept the responsibility for the specific ways in which they embody, visualise, and describe objects. What emerges is an image of knowledge as "embodied objectivity",[33] aware of its situation and positionality.

[31] Donna Haraway: Situated Knowledges (1988), p. 595.

[32] Ibid., p. 588.

[33] Ibid., p. 588.

DivE: Constitutive Partiality of Perspectives

Haraway's conception allows for a productive framing of knowledge generating practices within DivE. The wish for a neutral position facilitating a disinterested aggregation and utilisation of knowledge claims parallels Haraway's account of the invisible master subject. At the same time, DivE's operation of relating and confronting, rather than synthesising strands of knowledge claims can be construed in a new light.

Following the idea of situated knowledges, by pointing towards the fact that all perspectives are partial, DivE's procedures in fact *enable* objectivity rather than impeding it. Furthermore, practices of continuous translation do not seek to eliminate or close the gap between different perspectives. Instead, they try to establish a mutual sensitisation of participants, engender a consciousness for the specificity of differences between perspectives and individuals. Not only do they enable participants to relate their practices in order to continue a cooperative endeavour, in so doing they in fact enable production of what Haraway calls feminist objective knowledge. They allow participants to "join with another, to see together without claiming to be another."[34]

[34] Ibid., p. 586.

The production of situated knowledge is based on the awareness of conflicting interests and motivations at play within the

procedures that construct it. It furthermore points to the embodied character of both objects of knowledge and subjects articulating knowledge claims.

In order to conclude discussion of knowledge claims within DivE, the text will briefly highlight salient aspects emerging from relating analysis of patterns of cooperation with the conception of situated knowledges:

DivE: Motivations and Goals within the Interdisciplinary Process

As was apparent in relationship to knowledge claims, also pertains to the level of individual participants' goals and intentions during projects conducted. These may converge during a project's progress or they may not. Crucially, in the latter case participants gain an understanding of the specificity of their own set of goals and the way these are related to disciplinary framed knowledge claims. By making goals and motivations an explicit object of the methodological framework, warring interests and antagonisms can be accounted for in practice.

DivE: Status of Artefacts

The updated construal of knowledge claims has implications for the role of artefacts within the DivE process. The artefact is reimagined as a site of continuous contestation and negotiation. Its materiality finds itself redoubled into the spheres of the digital and physical. Physical materiality facilitates sensorial experiences rooting the artefact within a shared lifeworld. Digital materiality, while appearing as the product of profoundly positivist-scientistic practices, is in fact deeply ambiguous in nature. It is a materiality that both affords coordination and feeds misunderstanding. It is deeply implicated in power effects that constitute, uphold, and reproduce social relations both online and offline. Its complicated hidden nature helps to obscure the complex relations that produced it, while lending durability to respective practices.

DivE: Knowledge embodied by participants

Furthermore, the process not only brings forth artefacts but simultaneously reconfigures its participants. Procedures of mutual sensitisation render them perceptive to the intricacies of other participants' practices. They learn to frame their propositions in a way that allows others to relate to them, to interpret, reframe, and attack each other's positions. Through these practices of sensitisation and continuous translation modes of respectful antagonism emerge. Participants' sensibilities change as certainties give way to curiosity and the conditions of one's own disciplinary position become apparent.

Conclusion: DivE as Matrix of Situated Knowledges

What emerges within DivE is a network of partial perspectives, together with an account of their mode of production, their position within situations of negotiation and contestation. Knowledge claims within DivE always have to be read on the basis of their partial nature. In fact it is this constitutive partiality that renders them objective in the feminist objective sense. DivE's activities of material argumentation encourage formation of self-reflective theory able to account for the materiality and embodied characteristics of joint processes of digital making.

9.4 Claims + Hypotheses

In order to condense and summarise the intellectual work presented to the reader, the following section details a few key hypotheses developed during the course of the research endeavour described in this document. These cannot claim the status of proven propositions; they are claims endowed with plausibility through arguments made during preceding discussion and the successful conduct of the projects whose practice they informed.

- **Disciplinary Diversity can be Construed as an Asset**

  The DivE methodology is built around this hypothesis. It tries to organise differences between participants in a productive

manner, thereby transforming distracting misunderstandings into patterns of joint material argumentation. The successful conduct of DivE projects lends credence to the claim.

- **Design for Cultural Complexity Comprises Practices of Programming and Anti-Programming**

  Antiprogramming and Non-Use have emerged as key concerns during the design of prototypes for cultural education (see 9.1.3). One of the key challenges was how to design technology in a manner that allows it to facilitate cultural experiences rather than interfering with the appreciation of cultural phenomena.

- **Both Antagonistic and Convergent Processes of Discussion are Valuable within a Practice-Based Endeavour**

  Frameworks for interdisciplinary cooperation need not seek to quell antagonistic forms of discussion between different disciplinary perspectives. Passionate, antagonistic forms of discussion are able to invigorate processes of joint artefact construction as long as adequate methodological structures are in place. Antagonistic elements however, have to be rendered productive by interleaving them with phases of convergent making activities.

- **"Complexity and Complication" Provide an Apposite Discursive Frame for Interdisciplinary Negotiation**

  The distinction between complexity and complication (see 2.2.1) proved valuable in informing discussions between practitioners of computer science, design, art, and social science. It allowed to clearly describe differences between practices while pointing towards surprising parallels and points of convergence.

- **Digital Artefacts are Complicating Material Frames Modulating Complex Patterns of Practice**

  Digital artefacts could successfully be framed as *complicating material frames*. They modulate complex patterns

of practice by introducing regularities, asserted through the complicated material of the digital.

- **Digital Interactive Artefacts Contain Knowledge Regarding the Relationship of Complexity and Complication**

  One of the key elements of knowledge embodied by interactive artefacts concerns the relationship between complexity and complication. A successful artefact combines mastery of both: It presents a complicated digital system that is structurally sound. At the same time, it successfully interfaces with existing complex systems of practice, allowing itself to shape and interact with users' expectations and habits.

- **Epistemic Complexity Need not Overwhelm Poietic Efforts of Artefact Construction**

  Efforts to simplify or "dumb down" the complex questions arising from different epistemologies can eclipse the potential for unique contributions inhering within individual perspectives. Using adequate methodological framings, it is possible to situate and contain respective processes of constant negotiation in a way that is materially productive.

- **The Status of Hybrid Projects in Relationship to its Poles of Technology Research and Creative Production has to be Continually Renegotiated**

  Interdisciplinary hybrid projects contain both elements of technology research and creative production projects. Their precise situation with respect to both poles cannot be stipulated in advance but is subject to a process of constant renegotiation.

- **Digital Materiality Acts as a Key Category in Establishing Consensus During Negotiation**

  Joint making efforts depend on an adequate understanding of the digital material crafted by computer scientists. In order to achieve and improve this understanding, future conceptual developments and methodological extensions are advisable (see section 9.2.3).

9.5 Conclusion

The DivE methodology was validated through its application and refinement during three practice-based research projects. Issues regarding materiality, non-use, and performativity proved to be especially relevant. On a general level, the ability of continuous translation and situation of individual knowledge claims in relationship to others' positions emerged as a crucial feature of DivE processes.

10
Conclusion

[T]HE THOUGHT OF THE WORLD, DOES NOT APPEAR UNTIL REALITY HAS COMPLETED ITS FORMATIVE PROCESS, AND MADE ITSELF READY.

– GEORG WILHELM FRIEDRICH HEGEL

Development of digital artefacts relating to the complex field of cultural phenomena poses a challenging problem to the discipline of computer science: As computer scientists we share a love for systems, formalisms, exactitude – for complication and its ability to organise reality. We invent systems out of curiosity, or meticulously construct them in order to meet needs expressed in terms of functionality, usability, correctness, security, or reliability. We act on social reality by injecting complicated digital artefacts into complex systems of practice.

Cultural phenomena, however, do not always seem amenable to these exacting practices and modes of world-making. They appear as messy, entangled, ill-described, at the same time as too trivial to engage with and too involved to promise any satisfying solutions. Resultingly, engaging with cultural spaces constitutes an endeavour fraught with frustrations for any computer scientist trying to pursue it. Time and again, the computer scientist will find herself unsure about the presence of any clear cut problem to solve, will lack a familiar language to accurately describe cultural phenomena and to translate their complex social patterns into the complicated terms of informat-

ics. Problems do not readily present themselves but have to be painstakingly negotiated, while their validity and relevancy frequently remains contested. The amount of intellectual work necessary to frame and construct questions qualifying as problems in the eyes of our discipline can inflict a sense of futility on informatics practice.

Yet at the same time, computing technology permeates cultural spaces, as it continues to permeate every other facet of contemporary social reality: The way we gather, store, and transmit data influences how information is presented and acted upon in cultural spaces. The way we construct interfaces colours the experience users have of cultural artefacts and institutions. The movements and actions digital artefacts compel users to engage in are integrated into their practices and habits. Our artefacts become part of the material infrastructure of institutions and spaces, whether they are museums, galleries, or exist in the transient, disembodied zone created by mobile applications.

The way we design systems and construct artefacts in turn directly impacts cultural practice. Digital artefacts can distract from the materiality of exhibits in a museum or support and highlight them. They can isolate visitors or bring them together while facilitating lively discussion and fruitful social encounters.

It is hardly within our power to determine whether or not digital devices continue to pervade the realm of the cultural, rather the proliferation of digital technology presents itself as a feature of our times that we have to relate to. Hence, we share in the responsibility to negotiate how our artefacts shape these spaces whether we do so reluctantly or optimistically.

Consequently, informaticians find themselves confronted with the need to engage with cultural phenomena while possessing little clarity on how to do so. Without wielding analytic and formal devices to describe target domains, without requisite methodological means to facilitate structured inquiries and inform processes of making, our constructive and analytic endeavours alike appear to be in need of orientation.

In the absence of native methods to engage with cultural complexity on the part of informatics, a potential remedy exists in the form of interdisciplinary cooperation. This approach, however, effects challenges of its own: The question of how to organise the multiform array of disciplinary perspectives, methods, and constructive practices into a joint effort presents itself as a daunting task indeed.

DivE – A practice-based intervention

In order to productively address the underlying problematics, this thesis developed the DivE methodology for interdisciplinary prototyping. The outlined challenge of developing artefacts for complex cultural environments could successfully be met through specification of an adequate methodological framework. During this process, the situation of computer science could be successfully redescribed: It must neither remain focused on traditional modes of development restricted to complication, nor does it possess germane methods for addressing cultural complexity. It must not limit its theoretical vocabularies and methodological toolsets to the realm of the complicated. Computing science, however, can find an answer to the challenges presented by exercising its constructive powers while simultaneously reflecting on them.

Through joint readings of theoretical and material artefacts, disciplinary differences become visible in a way that allows for their productive utilisation: Convictions of project participants are translated into concrete requirements for artefacts. They are temporarily suspended during activities of artefact creation. Differences and convictions not translatable into artefact remain valid, constituting an essential part of joint processes of *interpretation* of constructed artefacts. Thus, multiplicity of perspectives, antagonistic theoretical commitments, and conflictual convictions become visible as potential assets to interdisciplinary projects of digital making.

The presented methodology allows for constant negotiation across disciplinary boundaries. The extent to which traditional

goal-based and practice-based methods are employed in each iteration is part of the process of negotiation itself. Dealing with the complex nature of the practices its artefacts become part of, as well as the complexities inhering within its own processes, could be identified as prerequisite for a reflective approach towards computing.

Thus, applied computer science is able to partake in explorations of the complex through its own medium: the construction, specification, and reconfiguration of complicated artefacts within complex cultural systems of practice. Digital artefacts thus become visible as complicated ingredients within a process of continuous exploration of and experimentation with complex practice.

Informatics practice thus emerged as a productive agent in a double sense throughout the argumentation process: As the producer of artefacts modulating the lives of their users as well as facilitator of interpretations of these artefacts. In this sense, it continues to challenge our ways of relating the semiotic and the material and urges us to apply critical spirit.

Reflecting Cooperation: Alienness + Antagonism

During the course of practice-based projects conducted, informaticians found themselves confronted by a perceived otherness associated with the realm of the cultural. The field of culture presented itself as an alien domain, fraught with intractabilities, instabilities, and ambiguity, stubbornly fleeing and frustrating our efforts of description, formalisation, and complication. Analogously, qualities of alienness manifested themselves within the structures of cooperating disciplines, running through their foreign procedures and practices, casting a strange light on their claims and communications, at times presenting their methods as inscrutable or inefficient, their epistemologies as circular and frivolous.

This perceived otherness in turn allowed us as informaticians to project our own desires upon cooperating communities, modelling them according to the wants and requirements of our own

disciplinary procedures and epistemological vacancies. Faced with the frustrating task of addressing cultural phenomena, we sought to delegate the work of engaging with complexity to the unfamiliar disciplines, thereby preserving the purity of our own. Within this imagined model of interdisciplinarity, the work of engaging with complexity can effectively be delegated to a discipline such as sociology or cultural studies. Once these other specialised communities have concluded their respective analytic practices, whose inner workings need not concern us, we can begin the proper task of engaging with complication.

The wish however that cultural studies, sociology, media studies, ethnography, or media psychology will engage with cultural phenomena on our behalf and emerge with descriptions befitting our own disciplinary language has not materialised in any of the projects conducted. Indeed, there might be good reason to believe it cannot come to pass at all, due to inherent structural dissimilarities between the epistemological communities involved. Cooperating disciplines' methods are not aimed at producing translations into the complicated structures required by many computer science practices. Their communications are expressed in foreign disciplinary languages, their claims framed within incongruous epistemological systems. Even if translations and delegations of this kind were possible, informatics would hardly be in a position to utilise them, for its sensitivity to cultural contexts and target domains evolves only gradually during joint projects conducted.

Crucially, the possible interrelationships between artefacts produced and systems of cultural communication are not known in advance to any discipline. Consequently, project aims and system requirements are subject to frequent revision, remain the topic of animated debate, and might not enter into a process of convergence at all. The mode of cooperation proposed here thus is one of mutual sensitisation and continuous negotiation. Most importantly, we cannot delegate our responsibility to judge the specific influence, the potentials and dangers that introduction of complication might have.

In fact, the deceptively clear cut distinction between computer science as technical engineering discipline and the seemingly external object of "culture" is itself fallacious. The perception of culture as an object sitting comfortably outside the domain of our focus is the product of a prereflexive stance which excludes our own discipline from the scope of our thinking.

Interdisciplinary cooperation serendipitously requires informatics to reflect on its own situation. In turn, it realises how it finds itself always already entangled in a complex web of social relations, how it establishes a disciplinary culture of its own, how its complications are only intelligible in relation to their complex other. This realisation might at first seem even more disorienting: Informatics finds it cannot distance itself entirely from the realm of the cultural, while its mode of producing social reality most manifestly differs from the languages of disciplines versed in analysis of cultural phenomena. However, if informatics accepts elements of self-reflection and introspection as prerequisites of knowledge production, it can hope to obtain a more nuanced image of its own practices and the communicative outcomes they engender.

During practice-based projects, these reflections arrived as an apparent by-product, brought about by project necessities. The DivE-methodology introduced in this thesis organised projects into networks of continuous retranslation and negotiation. It thus established a web of positions, fields of arguments and counter-arguments, intellectual trajectories and constructive efforts, at times nourishing and opposing each other. The emerging network of continuous translation and renegotiation forces project participants to relate claims, situations, and artefacts to one another, to continuously reflect on disciplinary borders. This allows for an ever shifting account of the specificity and situatedness of our own knowledge claims and vistas. If we follow the feminist-objectivist premise that objective knowledge is predicated on the realisation of the partiality and situatedness of any subject position or knowledge claim, observed cooperative patterns exhibit a productive epistemic dynam-

ics. In this feminist-objective sense, DivE's procedures can be construed as providing a methodological framework for gradual formulation of objective knowledge in the mode of material negotiation.

Abiding Antagonisms

Indeed, reflecting on the constitutive antagonisms experienced during cooperative endeavours might not only be necessary in order to realise the conditions of interdisciplinary cooperation but also contribute to a more adequate set of concepts on the level of theory produced. Antagonisms occur on multiple levels during practice-based endeavours, they manifest themselves during interdisciplinary negotiations and appear while observing cultural practice. In the absence of apposite methodological frames, they can overpower creative communicative dynamics, When framed adequately, however, they act as productive agents, invigorating debate and driving processes of making.

Cultural phenomena themselves are characterised by conflicting narratives, warring accounts of historical events, strategies and counterstrategies for achieving hegemonic interpretational dominance. They bear the marks of long-running struggles over construals, ongoing attempts of selectively privileging or silencing voices within cultural discourse. This inner dynamicity of the cultural frustrates any actor who wishes only to divulge indisputable facts, or to recuse itself from controversy. Already the act of constructing a medium through which accounts of cultural events will subsequently be communicated can make no claim to neutrality: every medium privileges certain narratives while remaining of limited utility to others. Building on these insights, we might no longer view antagonisms as problems to be solved but as symptoms of the conflictual structures within social reality through which informatics reproduces itself.

Following this intellectual trajectory, reality might no longer appear as homogeneous process, amenable to a harmonising account on the level of complication. Rather, it emerges as con-

sisting of myriad dynamic elements regularly opposed to each other while intermittently at odds with themselves. It presents itself as populated by conflicting interests, bound to incommensurable frames of reference, driven by antagonistic convictions expressed through incommensurable structures of mediality. Respective accounts of social phenomena thus confront us with the question whether we believe to be living in a world of logic or a world of contradictions.

Critique of Complication

Realising informatics' own position in relationship to other disciplines is predicated on reflecting on the characteristics and limits of its instruments of shaping social reality, its medium of expression, its mechanisms of encoding reality, of materialising artefacts. Informatics effects change within the world through introduction of formalizable artefacts, rule-based systems, programmed digital machinery. Consequently, it bears the epistemological weight of reflecting this need to complicate, to formalise, to enact repetition and uniformity within the domains it affects. This entails understanding the status of complication within contemporary social structure and analysing the specific mechanisms through which informatics establishes, maintains, and disrupts relationships between complexity and complication.

First, in order to situate complication within social reality, it is imperative to realise its constitutive role for contemporary life. In so doing, we discover how the relationship between complexity and complication indeed has to be thought as one of mutual conditionality. As thinkers such as Latour point out, contemporary society is unthinkable without processes of complication. Calendars, forms, laws, administrative procedures, office buildings, road systems, calculators, continuously impose a regularity upon social practice without which society would quickly fall apart. Importantly, we might not possess a model for thinking how a society on the scale of billions of individuals could exist without massive infrastructures of complication. Its

interactions would be burdened by a vastly excessive amount of complexity which no social being is equipped to handle.

Informatics participates in these continuous implementations of regularity through its specific modes of instituting complication. Interactive installations, user interfaces, social media networks, and similar actors ceaselessly complicate the interactive fabric through which society reproduces itself. Digital materiality lends durability and agency to said structures while at the same time limiting their visibility and selectively constricting their mode of alterability.

Understanding these processes and devices forms the basis for informatics to realise its own medium of world-making. Consequently, any creative or critical intervention by informatics is conditional on proficiency in the formulation and description of complicated structure. This in turn necessitates a solid command of the languages of complication as well as skill in the crafting of digital and formal artefacts. At the same time, informatics should be careful not to mistake complication for understanding as such. Every act of complication inevitably erases part of the complex phenomena it seeks to represent or interface with.

Ultimately, we have to arrive at a nuanced account of complication. It should not be treated as a perversion or reduction of a preexisting inherently rich social reality. Nor should it be confused with the only legitimate outcome of a scientific and exact practice, with complexity as the pre-scientific other or raw material of scientific formalisation processes. Rather, it points to a specific mode of social organisation, correspondingly languages used to describe it bear the marks of this specificity.

If we, however, disavow the situatedness of our knowledge claims, we not only obscure their specific epistemic value but also invite misuse and misappropriation. Languages of complication can fulfil a deeply ideological function when stripped from contextualising and reflective frames of reference. They possess the capacity to cast as neutral and scientific what is

political and contested, thereby divorcing objects from the very cultural and social contexts that render them intelligible.

Indeed, complicated structures continually interface with the cultural, social, and political environments that produce them: Digital artefacts fortify certain patterns of practice while discouraging others. Their development is driven by interests and motivations which in turn shape material infrastructures and system designs. They engender practices beneficial to certain social actors and detrimental to others, while their actions and designs often remain invisible to those affected. Complication is never innocent. It always unfolds in the face of alternative, competing and conflicting ways to complicate, to digitally materialise and thus to form and reinforce patterns of social interaction.

Questions regarding the construction of complications thus become legible as possessing a political quality: Who is aware of the material basis of digital structures invisibly shaping practice? How are processes of complication negotiated?

As experts in complication, informaticians also share a special responsibility for participating in respective negotiations, for reflecting on its limits, identifying its specificities and reasoning about its potentials and dangers.

Complication as Janiform Entity

Emerging analyses of complication are thus tasked with accounting for the ambiguous force of complication, its janiform ability to institute constricting regularities and to extend the limits of human freedom. It is precisely the respective mode of copresence of rigidly constricting and potentially liberatory effects that marks the unique situation of complication. Consequently, we have to be careful not to judge products of complication “en bloc”, either by highlighting a complex kernel of cultural life unamenable to attempts of complication or by insisting on a disciplinary culture compelled to complicate its objects. Not only is a simple distinction between culture and complication untenable, indeed it is possible for complications to open up the space for complexity.

Crucially, complicated structures need not inflict complication on their respective complex environments. A simple artefact ensemble, such as analogue camera and celluloid film, musket and cartridge, mangle board and rolling pin, or paper map and compass, forces its user to follow a specific protocol during every instance of use, thereby imposing complication on her practices. Infinitely more complicated devices such as modern digital cameras, washing machines, route planning services require little more than the press of a button. A simple factory based on assembly line production organises workers into processes of endless repetition, an infinitely more complicated one based on industrial robots greatly eliminates the need for human labour altogether. The human computers on which Turing machines were modelled remained engrossed in complicated practice. After deployment of electronic computing devices, the occupation of the human computer all but disappeared. Computers are able to absorb complication, creating space for complexity.

Likewise, we should resist the temptation to grade the distinction of complexity and complication on a moral scale or on one of social desirability: the matter at hand is not one of playing “good” complexity against “bad” complication.

A lynch mob constitutes a highly complex phenomenon, while a pacemaker is a complicated artefact. Honour killings are set in motion through a highly complex network of moral and religious institutions while solar collectors, defibrillators, and epi-pens are inherently complicated devices. Complicated structures supply cities with electricity, regulate temperatures and traffic flows, direct combat drones and emergency vehicles, wash clothes, clean floors, correct spelling mistakes, predict weather patterns, retouch photographs, automate exposure control, transmit movies, enforce shift plans, compute education benefits and social credit scores. There is nothing inherently favourable or damning about complication; accounting for its operation in essentialist terms remains futile. Instead, complicated devices present themselves as ambiguous actors of

social change, they can act as unyielding and stifling casts of social practice, or free up human time by eliminating mind-numbing routines.

Complication as Matrix for Complexity

Individual relationships between complex and complicated elements within assemblages of social actors cannot be assumed to be stable. Society generates an ever-changing ensemble of complications to which artefacts and actors have to relate in order to maintain their agency. This development in turn induces a dynamic series of displacements of complexity together with a remodulation of the heterogeneous networks of complex and complicated elements underlying respective practices. Resultingly, the space in which complexity is able to unfold and constitute itself continually changes shape, exposing unforeseen limits and unpredicted possibilities.

Regarding the realm of cultural experience, the described degree of dynamicity provides us with opportunities for experimenting with novel practices, testing the possible effects of materials, and observing engendered patterns of interaction. Projects conducted as part of this thesis exemplify experiments in this spirit: PRMD explores novel forms of connecting users through historical narrative. ASSMBLG creates new modes of bringing experiencing bodies in contact with exhibits. PRTL can be read as playfully relating elements of languages of complication with complex situations of communal experience and mutual discussion. Hopefully, they provide impulses for analyses and material explorations of the relationship of cultural complexity and complication. In so doing, they might explicate how practice-based research can be employed in order to collectively twist digital materials into shapes that give rise to interesting complications, which in turn nurture interactionally rich complex practices.

Actors interested in experimentation and research, however, are not the only ones faced with the necessity to intensively engage with processes of complication. Even realising a simple

preservation of existing complex practices is predicated on a solid understanding of phenomena of complication. Due to the changing nature of complicating environments, explicit interventions in the form of anti-programming can be necessary in order to effect complex practices which earlier seemed to emerge spontaneously. As was shown, complexity and complication constitute co-dependent phenomena, projects tasked with furthering one or the other inevitably find themselves tending to the relationship between them. In any case, whether we aim for preservation of complexity or seek to employ it as medium of experimentation, our actions are predicated on interdisciplinary dialogue with epistemological communities versed in description of the complex.

Resultingly, I do not propose appropriation of practice-based research as a means for informatics to "culturalise" itself or transform itself into a science of the complex. Instead, I argue for it to reflect upon its need to complicate, formalise, and construct. Taking up this challenge of reflection entails analysis and understanding of the shifting networks of complex and complicated elements through whose reconfiguration informatics acts. If we neglect this reflection, informatics runs the danger of perverting its potentials for creativity and critique, of blunting its analytic capacities and of squandering its potential for effecting change through creation.

Embracing these adventures of reflection, conversely, awards informatics an extended agency which it might employ to establish spaces for complex cultural phenomena, to facilitate and modulate novel practices, while playfully outlining and exploring the material conditions of their respective possibility.

Dénouement

Ultimately, wrestling with the problematic of complication touches on the insight that contemporary social existence hinges on the operation of intricate complicated infrastructures which remain alien to the complex life of feeling, sensing, imagining, and empathising. Informatics possesses the ability to embrace,

reconfigure, and creatively construct these otherwise latent structures composed of formal and digital materials.

If we want to designate a salient intellectual potential of informatics, we could construct it as an obligation to render its complications accessible to discourse, translate them into experience and artefact, expose them to scrutiny and critique, thereby invigorating debate and facilitating creative interventions. This entails the construction of discursive interfaces towards other disciplines, disclosing complication to communities less well versed in the arts of complication. If we choose to do so, we might elect to construct new visibilities, explicitly confronting complicated structures with the sensorial abundance and spontaneity of the bodies they affect. Hence, we might supply the material condition for realising how complicated structures result from and are reproduced through specific regimens of regulating practice, of distributing and withholding power. A stance emerging from these practice-based endeavours would neither amount to an abandonment to complication nor exhaust itself in a simple turn towards the complex. Rather, it emerges when critically reflecting our fascination with complication, tempering it with a love for complexity.

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IT SEEMS THAT EVERY TEXT HAS MORE SOURCES THAN IT CAN RECONSTRUCT WITHIN ITS OWN TERMS.

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