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# STS goes to school: Spatial imaginaries of technology, knowledge and presence

## Summary

The following text presents a revised and extended version of the public defence of my Ph.D. thesis presented at the Faculty of Social Sciences on 18<sup>th</sup> November 2005, Copenhagen University. The thesis applies and develops theoretical perspectives from Science and Technology Studies – especially Actor-Network Theory – in the empirical field of primary education. This field has not prior been approached by these theories. Based on ethnographic field studies the thesis presents and compares what I call *spatial imaginaries* of interactions of humans and learning materials in a traditional classroom and in a computer lab. The study describes and discusses the *forms of knowledge* and the *forms of presence performed* through these socio-material interactions. The study thus contributes a definition of *materialities* that takes the understanding of technology in education beyond the dominant humanist approach to schooling.

## Introduction

I was reading a book on classroom observation. There was a list of “illustrative examples” of research questions. These are some of them:

1. *What do teachers and pupils do in the classroom?*
2. *How do teachers manage their classes?*
3. *What do pupils learn?*
4. *What is a school day like from a pupil's point of view?*

5. *What happens to particularly able pupils?*
6. *How are classroom decisions made?*
7. *What happens when pupils disrupt lessons?*
8. *How can I improve my own teaching?*
9. *Is there continuity and coherence in the curriculum?*
10. *Do teachers in one school have similar or different practices?*
11. *Do teachers and children perceive the same events?*
12. *How is pupils' work monitored and assessed?*
13. *What happens when children work in small groups?*

*Excerpts from Wragg (1999 p.110-111)*

These questions are illustrative of educational research. I noted that they all concern teachers or pupils; that there were no questions about learning materials, about the layout of the classroom, about technology. Educational research is wholeheartedly *humanist*. It studies *human practice*. I wanted my thesis to suggest an alternative, and I went to study school practices but focused neither on pupils nor on teachers. I focused on technologies. I was fuelled by the observation that humans are not entirely in control of practices and that what

happens in schools is not simply due to the pedagogy, authority or style of teachers, to children's motivations and abilities, to modes of human interaction, to planning and structuring of lessons.

Following the *post-humanist socio-material* tradition of Actor-Network Theory (ANT) (e.g. Callon 1986; Latour 1987; 1999; Law 1994; 2002a) the thesis is carried by the assumption that, apart from social entities, high and low technologies take part in, and contribute to, forming school practices. Not just as means for human aims, but as *participants*. Thus preoccupied, the question I pose in the thesis is *how* technologies participate in school practices and *what* is performed through their ways of participating.

#### *Participation revisited*

The notion of *participation* is widespread within studies of learning (e.g. Dreier 1999; Nielsen & Kvale 1999; Lave & Wenger 1990). But how can we understand technology as a *participant* of practice? In reference to *personal* participation, Dreier identifies the notion of participation by the following features:

- It indicates that a participant is *always already involved in practice*.
- It emphasizes the *particularity* and *practical* nature of the participant.
- It points to the *partial* aspect of practice.
- It indicates that a participant is *always part* of practice, even when not reproducing but disagreeing with or changing it (Dreier 1999 pp. 5-7).

For Dreier the participant is always a person (Dreier 1993; 2005). Because my aim is to study the participation of technology and not mainly personal participation I need to some extent to depart from Dreier's theory. I however keep Dreier's four point definition of participation, but reading it from the Actor-

Network Theory perspective of *symmetry* (e.g. Callon & Law 1997; Johnson (a.k.a. Latour) 1995; Latour 1999) I take *participant* and *participation* to apply to nonhumans as well as to humans. This altered notion of participation invites us to study technology as one of the entities entangled in the practical accomplishment of particular practices. Hirschauer remarks that:

*Artefacts (a. o.) are not actors but participants of social processes. Suggesting this notion does not point to a set of situated participants as in Symbolic Interactionism nor the partakers in a democratic process (participation) as in political theory<sup>1</sup>, but to all entities that are involved in accomplishing practices in a way that is specific for them. The talk of participants lies 'on the linguistic level' of the talk of doing culture. Notably, the English doing is grammatically a present participle. It belongs to the so-called infinite verb forms that contrary to the finite forms are undefined in person and numbers. The actor is unimportant for the infinite verbs: Something does the 'smoking' – whether it is human, Colt, chimney or volcano.*

*Hirschauer 2004 p.74-75; my translation, emphasis in original*

While Dreier's four points emphasize the *participant's* entanglement in practice, Hirschauer uses the notion to render "all entities that are involved in accomplishing practices" pivotal in the study of technology (artefacts) and to keep any one actor or participant in the background of the *assemblage* of participants. If we translate Dreier's four points through Hirschauer's observations when talking about the participation of technology, we find that instead of studying technology as a more or less well-delimited object or actor, our description becomes focused upon *the assemblage of participants involved in accomplishing technological practices*. The practical assemblages of which technology is

<sup>1</sup> Nor, I would like to add, as a partaker of a democratic design process as in Participatory Design.

part become the object of study. Discussing technologies in terms of participation is thus a way of creating sensitivity to *how* they participate in school practice in different, surprising and unforeseen ways.

#### *Data and method*

The technology in focus of my study is an online 3D virtual environment<sup>2</sup>. Such a computer program runs on personal computers and presents the user with a graphic world in which she can move around a little character – a so-called *avatar*. The virtual world is online, which means that other users can log into the same world and communicate and interact with your avatar in the virtual environment. Furthermore, users of the virtual environment can build homes, landscapes, fire stations etc. inside the virtual world. Together with my research group<sup>3</sup> I designed this technology to run in a Swedish and a Danish 4<sup>th</sup> grade class who collaborated over the Internet. We called the design *Femtedit*.

I studied how Femtedit participated in practice by collecting data in three fields:

- I was an observing participant for seven weeks in the Copenhagen part of the Femtedit project, studying how the online 3D virtual environment participated in this practice.
- I studied the design processes prior to running the Femtedit project as well as the ongoing design processes that ran parallel to Femtedit.
- I went to the Copenhagen 4<sup>th</sup> grade class and did participant observation in the classroom, studying how the traditional low-tech learning materials such as rul-

ers, blackboard, notebooks etc. participated in this practice.

With the notion of *patterns of relations* the thesis describes the socio-material relations that made up the Femtedit design and practice as well as the classroom practices. This includes describing the principles these relations performed for what counted as an object, as differences and similarities, as continuities and breaks. Describing an online 3D virtual environment thus becomes a matter of following the objects as they relate and describe the *patterns* that these relations form.

The thesis is divided into three parts. The first part asks the question of *what* is a technology, while the second and third parts look at what the technologies *do* in practice – at their *performative effects*, as I call them: *Forms of knowledge* and *forms of presence*. Even though the main interest of the thesis is theoretical it does not dwell in isolated discussions of theory but processes theory through empirical analyses. In order to provide an impression of how the thesis applies its theory and methodology, I focus this presentation on giving examples of the empirical analyses, although in this paper, these are only sketches of the longer and detailed ethnographic descriptions readers may find in the thesis (Sørensen, forthcoming).

## Part 1: Technology

### *Network imaginary*

Following Law's (1989) notion of *heterogeneous engineering*, I describe in part 1 the process of *constructing* the Femtedit design of the online 3D virtual environment: how social *and* material entities came to be connected. The online character of the technology required *social* efforts in order to work. It did not work simply due to technological devices, to the broadband cables drawn between Co-

2 For further description, see <http://www.activeworlds.com/edu>

3 Consisting of Nina Armand, Agnete Husted-Ander- sen, Morten Jack, Kenneth Jensen, Tine Jensen and myself.

penhagen and the Swedish town Ronneby, and to computers connected to the Internet. These technological devices had to be connected with the social efforts of children, which did not include merely putting children in front of computers. Because these children were not isolated social beings, but already entangled<sup>4</sup> in a socio-material web, which the work of connecting them to the online character of the technology had to handle. We thus added an organisation that among other things would make the time schedules of the two 4<sup>th</sup> grade classes match, and divide the classes to make the number of children in one fit to that of the other. If this organisation were not added, the social efforts of the children would not connect to the technologies, and thus, no bits and bytes would ever travel between the two schools.

Adding social efforts to technology was however not sufficient to make Femtedit work. Likewise, social efforts had to be associated with technology in order to be mobilised. From a pilot study, we knew that the children would not necessarily start interacting just by being confronted with the virtual environment. We had to construct the children's *motivation* to communicate. We did this by providing them with a mission that required communication in order to be completed. The mission was about together creating the identities of the virtual creatures – the Femteditians – who lived in Femtedit. These identities were established by making hyperlinks from objects in the virtual environment to Internet sites, which could be taken from wherever the children came across a URL in their everyday lives. So, like the technology was entangled with a web of social efforts in order to work, the social aspects of the project needed to be entangled in a technological web in order to emerge.

By hence focusing on the *construction* of technological design as a heterogeneous engi-

neering I show in the thesis how the technology indeed was an assemblage of human and non-human elements. I call this construction story of how humans and non-humans were connected a *network imaginary*. It describes the technology as a network of *heterogeneous* elements, which were *firmly tied together* in order for the technology *to work*. As long as its components *stayed together and in place* and as long as each of them *did its job*, the technology would be *stable* and *intact*. The network imaginary is the first empirically based definition of technology I present in the thesis. It follows the conception of what I call *classic ANT* (e.g. Latour 1987), and it does indeed match most common sense (and most theoretical) understandings of technology as something robust and stable, durable and functional. Less common sense is the idea of technology as heterogeneous, as entangled social and material entities.

#### *Fluid imaginary*

The next chapter in the thesis is called “Things that don't quite fit”. Even though the network imaginary of Femtedit seemed to be a comprehensive description of the technology, elements appeared that did not work according to the network imaginary. New hyperlinks continuously added to the virtual environment changed the character of the environment. Computers froze and required of the researchers to take on the tasks of technical aids. Plans for the unfolding of the project were altered, etc. Elements – like the plans, the virtual world and the role of the researcher – did not stay in place as suggested by the network imaginary. Many instances appeared in the data to which the settled character depicted by the network imaginary did not quite fit. Instead, the socio-material reality of how the technology participated in practice was characterized by *little recurring interventions, adjustments and rearrangements*. Some elements displayed rather a pattern of *ongoing trials* that had to be

4 For further discussions on the notion of entanglement, see the introduction to Callon 1998.

solved than the tight assemblage characterising the network imaginary. Following Law and Mol (Laet & Mol 2000; Law 1999; 2002b; Law & Mol 2001; Mol & Law 1994), I call this different description of the technology a *fluid imaginary*. It suggests an understanding of technology as much more flexible and mutable than the common – and network – understanding allows. This move from a network imaginary to a fluid imaginary of technology corresponds to the theoretical move from *classic-ANT* to *after-ANT* (e.g. Law & Hasard 1999); the latter represented by among others Law and Mol.

So, you may wonder, did the technology perform network or fluid patterns of relations? No, it performed *both*, I argue. Mounting one of the hobbyhorses of *after-ANT*, I argue that Femtedit was *multiple* (e.g. Mol 2002, Law 2002) and that a technology may be stable and fixed, while at the same time being flexible and open-ended. I talk about Femtedit as *network*, and I talk about *fluid* Femtedit. Later I even also talk about *regional* Femtedit. I describe how a technology can be different technologies, while still being one. This changes the way we may think of a technology. Of what counts as inside and outside of a technology, of when we can say that a technology fails, of how a technology can be itself, centred, while at the same time being distributed.

## Part 2: Forms of knowledge

In part two and three of the thesis I turn to analyse *performative effects* of the *fluid* patterns of relations of Femtedit. I focus the analyses of the rest of the thesis on fluidity as a counterweight to most literature on technology, which far more often emphasises the standardising and stabilising effects of technologies than their flexible, mutable and open-ended characters. The analyses of fluid patterns of relations is however not isolated from other performances of technology, from

network or regional imaginaries. Connections between different performances of socio-material patterns of relations are drawn through comparison. These arise by juxtaposing the patterns of relations performed in the traditional classroom with those performed in the computer lab.

### *Representational knowledge in the classroom*

Part two starts out in the classroom. The teacher read from the maths exercise book about Jens who made a two metres long jump. She looked up from the book and asked whether that was a short or a long jump. When asked, Kim answered “short” in low voice. The teacher now asked Kim to step ahead to the centre of the classroom. She drew a chalk-line on the floor in front of his feet and asked him to jump as far as he could from that line. He jumped. She drew a new chalk line at the point he reached, and with a large one-metre ruler she measured the jump to be 93 cm long. Subsequently, she asked Kim if he now thought that a 2-metre jump was long or short. Kim answered “long”, and was told to go back to his desk.

I analyse this sequence by looking at the *patterns of relations* that were performed through the ways in which the involved social and material entities were related. The practice in the classroom connecting the bodily activities of jumping, the materialities of the chalk-lines on the classroom floor, and the ruler could – through the one-metre standard – be translated into a matter of numbers and assessments of lengths. And because of this translation, the local and socio-material activity of the classroom could be compared to the story written in the exercise book about a quite different activity.

I show in the thesis how a pattern of relations was thus performed, which established a *region* of knowledge of length located in Kim, a region of the standard to which this knowledge referred, and a *boundary* between the two which separated the standard side of the



knowledge from the human side. I call this a *representational form of knowledge*, because this knowledge is characterised by regions with a representational relationship: the knowledge located in Kim represents that of the standard. I describe how this representational form of knowledge requires that the materialities involved in performing it are *stable*. If the learning *technology* in terms of the numbers in the maths book describing the length of the jump (2 metres) would in some mysterious way suddenly start to vary, the knowledge it presented could no longer be referred to by Kim stating a number or assessment of a length. Similarly, the (*human*) knowledge about the length located in Kim or in the class had to be fixed: the link between the human part of the knowledge and what it referred to – the numbers in the book, representing the standard – would be lost if the human side of the knowledge were to vary. The human side could only be considered part of representational knowledge if it displayed certainty and immutability.

After the analysis of the representational knowledge in the classroom, I turn to one of the classics of Science of Technology Studies (STS), Shapin & Schaffer's (1985) "Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life". During my studies I noticed an interesting parallel between the experimental knowledge arising in the 17<sup>th</sup> century described by Shapin and Schaffer and the representational knowledge in contemporary classrooms. The parallels teach us about the implications of this specific form of knowledge. Due to its material stability it is able to establish connections far beyond the walls of the laboratory – and beyond the walls of the classroom – and thus to be part of a *universal* knowledge.

#### *Liquid knowledge with Femtedit*

The discussions now move to the computer lab and the online 3D virtual environment to analyse the forms of knowledge performed here.

The children were creating the identities of the virtual creatures who lived in Femtedit. This was done by making hyperlinks from objects in the virtual environment to Internet sites. Through the hyperlinks these elements from outside were *involved* in Femtedit. Indeed, they were *involved* among other elements of the class such as the virtual environment, the research project etc. Through this involvement new and unforeseen connections were established. The elements brought into Femtedit were neither referred to nor represented in Femtedit. They entered to form *part* of the identity of Femtedit and the Femteditians, not to represent something somewhere else. Thereby, the 'outside' of Femtedit from which elements were 'brought into' Femtedit was differently constituted from the 'outside' of the classroom to which elements referred in the representational form of knowledge. Through the process of *involving* elements from outside Femtedit into Femtedit no boundary was created that separated a human side of knowledge and a standard it represented or referred to. Instead, an ongoing process was established in which new 'outside' elements were continuously integrated – and thus forming an *extended* pattern of relations. The result of this was that what was created continuously changed. This mutability allowed no stable, well-defined regions (inside and outside) to be established.

I call the knowledge produced with Femtedit *liquid knowledge*. It is characterized by its effectivity rather than by representation, by which I mean that it was the practical effects of it – how it could be continued and worked on and how it could make a difference – that were important. It was not the ability to represent a distant reality. Liquid knowledge is *procedural*. It was changing together with the changing of the materialities involved. The liquid knowledge lay in the buildings, links, chats and dialogues, etc. created by and through the online 3D virtual environment.

Liquid knowledge created problems for the teachers involved in the project even though it was difficult to test and even to account for because this knowledge did not display the stability and boundaries required to establish representational knowledge. There is a strong pressure on teachers and schools to be able to account for what children learn. Teachers can quite easily account for children's achievement of representational knowledge because it is well defined and stable *and* because it refers to standard elements that are widespread – outside the classroom – such as the one-metre standard, which also the parents, the headmaster – and members of society at large – can refer to, and thereby connect to. Being unstable, changing and not well delimited, these *witnesses* of school, as I call them, are not able to recognize liquid knowledge, and hence neither to grant it, if not the universality, then at least the public validity, that they could grant representational knowledge.

I end part two of the thesis by concluding that while witnessing is connected to representational knowledge<sup>5</sup>, the way in which one can engage with liquid knowledge is through *witnessing*<sup>6</sup>. While witnessing requires a distance to the knowledge that is to be witnessed, witnessing means staying with the liquid knowledge in a way that lets the procedural production of the socio-material practice that liquid knowledge is, continue transforming.

I hope this short sketch of some of the analyses of the thesis has provided an impression of how the study through detailed microanalyses of socio-material practice shows the way social and material elements are intimately entangled in the production of knowledge in school. And that the materialities of learning materials in

school are crucial for the forms of knowledge performed, for the organising of school, and not the least in shaping the relation between the inside and outside of school. The literature on knowledge and knowledge production is pervaded with debates of whether knowledge is abstract and universal or locally embedded in practice (e.g. Hutchins 1995; Lave 1988; Shapin 1990). Taking a point of departure in the latter position, my analyses however show that it is not 'either or'. The representational form of knowledge does indeed perform universality and abstractness. But these characteristics arise out of their practical nature of knowledge production. Knowledge production is local in the sense that it is practised *somewhere*, but *not* in the sense of this *somewhere* being a singular time-space situation. By focusing on the relations of social and material entities I show how 'outside' and 'inside' are performed differently with different patterns of relations, and how these patterns in different ways connect extended socio-material entities over time and space. It is notably these different spatial patterns of relations that give rise to different forms of knowledge, which may have the characteristics of being 'local' or 'universal'.

### Part three: Forms of presence

Part three of the thesis turns to another performative effect of the online world. It concerns *forms of presence*. I ask in which ways human participations were performed due to the involvement of the virtual environment. *Presence* is a term I came up with when looking for a way to describe human participation. Other theorists discuss 'subjectivity', 'individuality', 'personality', 'agency' etc. to portray human participation. These terms all grant 'humans' general identifiable characteristics. In order to create empirical sensitivity to how humans are *performed* in practice, my approach does not allow such a priori generalities. Thus, the notions of subjectivity, individuality, personal-

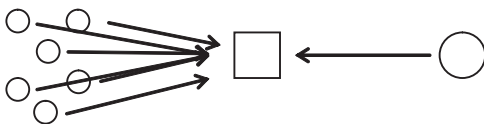
5 Witnessing is also a crucial element of the discussions of experimental knowledge in Shapin & Schaffer (1985).

6 This notion is taken from Despret (2004).

ity, agency etc. were too saturated with connotations or meaning for my study. Instead, I picked the notion of presence as a – quite empty – superordinate term of human participation. Other notions of human participation<sup>7</sup> were in turn drawn in as *inspiration* for the empirical characterisations of different forms of presence in the sense of *suggestions* for descriptions. These suggestions were compared to the empirical findings and entered the analyses to the extent they were found to match the data.

#### *Authority vis-à-vis subjects in the classroom*

The blackboard is a central material in my analyses of forms of presence in the classroom. I analyse a situation in which the class sings the alphabet song while the teacher is writing letters on the blackboard at the pace of the letters appearing in the song. All children are attended towards the letters on the blackboard, in parallel, so to say. Thus, a *one-to-many* relationship was established between pupil and the teacher-blackboard hybrid, as depicted in figure 1.



**Figure 1**

Children paying attention to the emerging letters on the blackboard. Large circle: teacher; square: blackboard; small circles: pupils.

The thesis describes how the blackboard was associated with the teacher. The teacher most often wrote on the blackboard. And it was performed as an exception when pupils did

so – through applauses and other exceptional reactions. I describe how I repeatedly observed the ability of the blackboard to attract and keep the whole class’ attention – due to it being a big visual field in the classroom. Much like a puppeteer, the teacher with slight wrist movements held the gazes of the children in his hand when writing on the blackboard. Associated with the teacher the blackboard effectively contributed to performing the teacher’s form of presence as *authority vis-à-vis* the pupils’ form of presence as *subjects*. I describe how a physically invisible but socio-materially very obvious boundary was drawn between the area of the blackboard and the rest of the classroom, and how this line simultaneously was drawn between and contributed to performing an authority and subjects.

Furthermore, through ethnographic descriptions I explain how a geographical ‘here’ and ‘there’ was created by way of the blackboard. The letters were ‘here’ on the blackboard, and the children attending the letters were ‘there’ (or vice versa, depending on the perspective). Among other things, the geographical distance was also emphasised by the wording “come up to the blackboard” and “you can go back down to your seat”. Two different regions – or separate areas – were performed through the interactions with and around the blackboard. One containing the authority, one containing subjects.

#### *Agents with Femtedit*

I found a quite different form of presence with Femtedit. Due to the materiality of the virtual environment it was not possible for the teacher to have an overview of what all children were doing at the same time. She walked around from one child to the next, looking into one’s screen, talking to another. Sometimes, she would log into the virtual environment and interact with the children via their avatars. But she always only had a *one-to-one relationship* to them.

<sup>7</sup> These are especially Asplund’s (1985) notion of the individual vs. the collective, Giddens’ (1984) notion of agency, and Althusser’s notion of subjectivity (ref. Law 2000).



We may think that this was due to the fact that children were working on their own – just as they sometimes were working on their own in the classroom, with their exercise books for instance. But there are important differences between exercise books and the online 3D virtual environment. First of all, because all children's exercise books were essentially *the same*, all children were doing more or less the same. And due to this materiality of the exercise books the teacher would know what all children were doing even when pupils were working on their own and the teacher only attended one at a time. Thereby, she could keep a *one-to-many relationship* to the children even when interacting one-to-one with them. Secondly, the exercise books *stayed* the same. The exercises printed on page 24 would not suddenly change and present the child with unexpected exercises. They would stay as they were printed, and as the teacher knew them. Because of this *immutable* or *stable* materiality of the exercise books the teacher was able to *predict* what one pupil would be doing even after she went on to attend another pupil.

This was quite different with Femtedit due to the building and the linking with materials from outside (what was going on and what was built and linked to) that changed continuously. This *mutability* left the teacher without any chance of predicting what children would do next. Predictability – which is a crucial component of authority – requires *stable* and *immutable* materialities that the online 3D virtual environment did not perform. Lacking both stability and sameness across the class, Femtedit did not contribute to performing the authority-subject forms of presence as did the materialities of the classroom.

On the contrary, I describe how the one-to-one relationship between teacher and child performed with Femtedit was characterised by two equal participants who each influenced and made a difference in the situation. I call

this form of presence *agential*. Teacher and children shared this form of presence.

In the computer lab, teacher and children could not rely on a pre-given common reference, as they could rely on the exercise books in the classroom that connected (and contributed to forming) their *different* presences. Instead, teacher and children collaborated on common tasks on the basis of more or less the same possibilities. Through this collaboration, the online virtual environment contributed to establishing a much closer relationship between teacher and children than did the materialities of the classroom. The two *regions* of authority and subjects we saw in the classroom and the clear *boundary* and *separation* between them were not performed with Femtedit<sup>8</sup>.

I finish part three by discussing whether authority is at all impossible with a fluid technology like the online 3D virtual environment. I note that the way we usually understand authority is similar to how it was performed in the classroom, as two regions of authority and subjects, respectively, who are clearly separated and which allow one to exercise authority over the other. The thesis suggests an additional understanding of authority, based on fluid patterns of relations. Thereby, we can start thinking constructively about how to establish a different *form* of authority with technology instead of discussing in terms of presence or absence of authority in technological education, as it is most common in popular as well as scientific debates (e.g. Lee 2001). Authority based on fluid patterns of relations could be established as *authority of the preceding step*. This follows the logic of the

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8 However, at times this socio-material arrangement also *disconnected* the teacher entirely from what the children were doing. Moving on from child to child, she lost the connection to the child she just left. On the basis of these findings the thesis discusses the difference between separation (in the subject-authority pattern of relations) and discontinuities (in the agential pattern of relations).

arrangement I observed in the Femtedit project in which authority could be cultivated as little recurring interventions, adjustments and rearrangements that would be suggested through the teachers' involvement in the project, not as a regional power which children could live up to or not, but as contributions continuously on trial. Through these trials, the interventions would contribute to forming the activity, and hence (liquid) knowledge as well.

I conclude part three by characterising the analyses of forms of presence with different materials as an example of a *post-humanist* approach of human presence. An approach that takes *materialities* into account, and which understands human presence as an *effect of the arrangement of social and material entities*.

## Conclusion and consequences

I call the descriptions of patterns of relations I provide in the thesis *spatial imaginaries*. The notion of *imaginaries* is taken from Marcus (1998) and refers to a readiness, a logic or sensitivity to describe, understand or interact with the world in particular ways embedded in our ways of thinking and acting. It is important to note that imaginaries are constituted in organised fields of social practices and not to be understood as idiosyncratic fantasies.

The different *forms* of knowledge and *forms* of presence I present are understood as spatial imaginaries. The notion of *spatiality*<sup>9</sup> invites an appreciation of objects<sup>10</sup> as being distributed over space, contrary to the thinking of objects as centred. Apart from empirical findings about technology, knowledge and presence in school, the thesis thus establishes a definition

of materiality that takes its point of departure in relations rather than entities. This means that we can think of the materiality of technologies just as well as of the materiality of social entities. Materiality is defined as the ability of a particular object – achieved through the socio-technical arrangement it is part of – to relate to (an)other particular object(s). Through a focus on the patterns – or spatial formations – arising through socio-technical relations this definition leaves behind the humanist understanding of technology in terms of its meaning, function or in other ways significance *for* humans. This definition, however, also departs from the understanding of materiality as the non-human or technological, as we see it in ANT. Indeed, the definition altogether moves the focus away from entities (even if symmetrically treated) to the focus on relations. And thus from a focus on *kinds* to a focus on *forms*.

It is important to note that *patterns* are not understood as the properties of certain spatial formations or the generalities of certain relations. Varenne & McDermott (1998 p.12) emphasise that entities that together make a pattern gain their particularities because of the ways they are arranged with other entities. Even though Varenne & McDermott are not writing in spatial terms, their observation is useful for my purposes. Spatial imaginaries are about describing the patterns in which entities are arranged or relate, which is a way of characterizing the *particularities* of the object of study. It is not, as the notion of patterns is sometimes understood, an attempt to generalize. On the contrary, it is a sensitivity to describe particularities as *effects of relations* – of distributed or spatial relations.

Following this methodology I refrain from an *evaluative* approach looking for *more or less* knowledge or presence or *better or worse* knowledge or presence. Instead, my approach is *descriptive*, looking at how knowledge and presence were performed as *different* patterns of relations. This allows me to stay close to the

9 My thinking in terms of spatiality is mainly inspired by the works of Law (2002a) and Thrift (1996; Crang & Thrift 2000).

10 My use of the notion of object here refers to human as well as non-human entities.

level of practicalities, and it lets the descriptions of practicalities be explanatory for what is going on.

This, like ANT in general, may be misunderstood as empiricism, which ANT – and I – however strongly oppose. The understanding of spatial formations and spatial imaginaries as *effects* of relations implies a preference for procedure, continuation, consequences etc. This fluid character also applies to the research process, which I find beautifully described in Henaff's discussion of Serres' understanding of the procedural:

*Procedural: This term has its origin in **procedo**, the act of walking, or rather moving forwards, step by step. This also means to advance among the particularity of sites and conditions. Can one define a way of thinking based on such a model? Is it not precisely what proper philosophy denounces as empiricism? Not even that, for at the end of the journey, empiricism intends to rejoin the universal it did not posit at the beginning. We are dealing here with something quite different – that is, taking seriously the particularities of the sites, the unpredictability of circumstances, the uneven patterns of the landscape and the hazardous nature of becoming. In short, again: how to think the local? Which means: is there a science of the particular?*

Henaff ref. Bingham & Thrift (2000)

More than discussing theory with the aim of reaching to a more coherent, more comprehensive or more generally valid account, my thesis *processes* theory through empirical material. Its aim is to contribute to theoretical and practical processes with metaphors, methods, examples and theory that can be taken up as a whole or partially, translated and applied by others in continuous processes that change as they move on in diverse directions, rather than sum up to a solid and immutable form. We may think of the value of such a work in terms of *performative validity*. Such validity cannot be defined with isolated reference to the properties of the text but only through

how it may be taken up and continued. This is not an attempt to exempt my thesis – or myself – from liability. It is an attempt to establish an alternative to empiricist understandings of scientific work as a matter of establishing truths – as representational knowledge with *representational validity* – which may thus be evaluated in terms of truthfulness. Comments and critiques – or the absence of such – of my (and other's) work are ways of bringing it along or not, of producing consequences or avoiding these, of involving it in scientific (or other) processes or failing to do so. This approach to scientific work is an invitation to use research as material contributions to what may become appropriate. It thus grants less importance to the individual works of scientific research, and more to the continuous processes of science and research.

With these last words, I would like first to thank the reviewers of my thesis (Morten Nissen, Vinciane Despret and Nick Lee), and you, my reader, for reading and thereby already investing efforts into bringing along the contributions of my thesis into a scientific process, and secondly to invite you to do with it what becomes appropriate.

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