FREE SOFTWARE TO OPEN HARDWARE

CRITICAL THEORY ON THE FRONTIERS OF HACKING

Johan Söderberg

UNIVERSITY OF GOTHENBURG
DEPT OF SOCIOLOGY

STS Research Reports 17
Johan Söderberg
Section for Science and Technology Studies
Department of Sociology
University of Gothenburg
Box 720
SE 405 30 Gothenburg
Sweden
johan.soderberg@sts.gu.se

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Författare Johan Söderberg
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For those curious to find out the content of the picture on the cover, this is for your information: Each pixel stores a byte value from a sound file. Data (490x490 bytes) should be read row by row, the last 256 pixels are the key, 16 bit PCM, little Endian, 8000 Hz.

ABSTRACT

Starting from the experiences of hackers developing free software and open hardware, this thesis addresses some key and recurrent themes in the field of Science and Technology Studies (STS). It poses the question: how are technologies conceptualised, constructed and used in ways that render some aspects of them transparent, while leaving others opaque? This question is complicated by the fact that what is visible and transparent to some will remain opaque to others, depending on the level of technical expertise commanded. The political implications of this stand at the heart of my inquiry. Since technical know-how is unevenly distributed among groups in society, the same concern can be rephrased as follows: How are relations of power and conflict mediated through technology and relations of technical expertise/ignorance? While trying to address this question, the thesis delves into matters of epistemology. Just as programming skills are required for seeing what is going on behind the computer screen, so theoretically informed reflection can be considered necessary for rendering visible social relations not immediately apparent to the casual eye. Discussion of the actions of hackers is therefore combined in this thesis with discussion of the alternative programmes of research which can be applied to the study of these actions. Two programmes of research in particular receive attention: the critical theory of technology and constructivist science and technology studies (STS). Of these two, the relevance of the former tradition is emphasized and its value for research in the STS field defended. The thesis is composed of four articles and an introductory chapter summarizing and encapsulating my concerns. The first article discusses belief in technological determinism among hackers and how this does not necessarily stand in opposition to political engagement. On the contrary, it is common within hacker politics for contending viewpoints to be articulated in relation to seemingly apolitical narratives about technical neutrality and progress. The second article also deals with antagonistic relations at the heart of processes of technological change. It argues that the punitive actions of law enforcement agencies provide a clear indication of the presence of asymmetrical power relations in technological change through, for example, attempts to suppress filesharing inventions. Hackers are negotiating with legal authorities and the mass media, but also amongst themselves, about how to draw the line between the legitimate users and harmful misusers of technology. The third and fourth articles are based on a case study of a group of Czech hardware hackers who invented a wireless network technology for sending data with visible, red light. The challenges faced by these hardware hackers in their attempts to design technical solutions capable of being built by non-expert users are discussed at length in a theoretically-informed fashion.

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In addition to those already mentioned who have contributed directly to the development of my thesis work, my thoughts go to my friends and close ones who have followed me during these years. First and foremost, I dedicate this work to my mother, Bodil Söderberg. Without her support and endurance the current PhD thesis would not have come about.

Johan Söderberg, Göteborg, January 2011

Part One

one

Introduction

Darknet of Light

A few years ago, if you happened to look out over the rooftops in a Czech town at night, you might well have seen red lights glowing on the horizon. Perhaps an association to cyberpunk would have crossed your mind. Such a nocturnal aesthetic was cultivated by the members of the wireless network community who built the light transmitting devices. These devices, called 'Ronja', were responsible for more than a light show as they served to link computers into a network. Where the onlooker saw light beams, there were in fact streams of data crossing back and forth over the rooftops. Many of the users of Ronja were students living in tower blocks. Among them, some had elderly neighbours who did not appreciate the light show. Furthermore, these irate neighbours were often influential on local housing committees. They had, in other words, the authority to tell the young residents to take down their devices from the buildings. This happened frequently enough to motivate the participants in the wireless network community to look for a technical solution to the dispute. They came up with a modified version of Ronja called 'Inferno'. With Inferno, data transmission takes place in the infrared as opposed to the red region of the electromagnetic spectrum. The technical performance with regards to interference from rain and fog is basically the same for both kinds of light. However, the problem of interference from angry neighbours is markedly lower with Inferno. Thus, the stream of data was able to flow freely once more over the heads of the unwitting neighbours.

This anecdote, which was related to me during my fieldwork studying the Czech wireless network community, illustrates a key issue in this thesis: Through which processes are technologies constructed, practiced, and conceptualised so that some layers of reality are rendered transparent while others remain opaque? The question is complicated by the fact that what is visible and what is concealed in any given technology depends on the technical expertise of the ob-

server. Furthermore, since this knowledge is unevenly distributed among groups in society, the question must be rephrased as follows: how are social conflicts mediated through technology and technical expertise/ignorance? This leads me to an old sticking point in the field of Science and Technology Studies (STS), the one centring on the relationship between politics and technology. For something to become a publicly contested issue, it must first be recognised as such by the parties involved. Hence, to render something invisible is a political act of the first order.

There are an abundance of cases in the history of technology showing how potential conflicts of interest have been overcome through design choices producing invisibility. The anecdote above offers a way of initially reflecting over such cases. By going from red to infrared light, a matter of contestation was literally removed from view. When this example is extended to include the computer network as a whole, with its multiple layers of hardware, protocols and applications, the degrees of transparency/opaqueness multiply beyond comprehension. It might be objected that such reasoning about politics is rather overstated for an example which merely concerns a potential dispute between neighbours. The matter gains in gravity, however, when recalling that the bulk of the data carried by the light beams was violating Czech and international copyright laws. Indeed, one of the goals of the main developers of Ronja was precisely to build a computer network which would be able to evade law enforcement agencies and other kinds of government regulation. Ronja was, so to speak, a 'darknet of light'.

Key Concerns

The intervention by the wireless network activists might be welcomed by some as a novel approach to politics. If so, this alternative way of doing politics comes with impediments of its own. Many of the Czech hackers I talked to lamented the difficulties of thematizing computer-related issues when addressing a broader public. They identified a need for raising general awareness about technical systems in society. This is required so as to enable ordinary users and citizens to understand the democratic implications of the spread of digital rights management technology, the principle of net neutrality, or the introduction of software patents in the European Union, just to mention a few recent controversies. In other words, the Czech hackers attested to the fact that technical know-how has become a prerequisite for rendering issues like these visible, and thus, contestable in society. This connects to an ancient predicament in political

philosophy: the link between knowledge and empowerment. The knowledge in question is not familiarity with computer technology but with philosophical reasoning. According to the Enlightenment tradition, a capacity for theoretical reflection is required of the citizens if they are to raise themselves above the immediacy of the present. Only then will they catch sight of their own circumstance and render visible the forces which act behind their backs. Thus the citizens can become sovereign. This statement invites two common objections. Firstly, it has been questioned as to whether such transparency of society can ever be achieved. Secondly, the role of the intermediaries has been repeatedly scrutinised: the work of representation, and the role of experts and intellectuals. The well-known dilemma goes as follows: how can the ordinary citizen be educated accordingly without it resulting in that her sovereignty is cancelled out in the process (Fischbach, 2009, p.84).

These are the themes I have set out to discuss in this thesis. I do so by focussing on the specific concerns of wireless network activists, free software developers, open hardware tinkerers, in short, those I elect to categorize as 'hackers'. Theoretically, I firstly draw upon and seek to enter into conversation with the *critical theory of technology*. This is an intellectual tradition which wrestles with the theoretical-political concerns sketched out above. The aim is partly to confirm the value of critical theory as an intellectual resource in social studies of science and technology. One tenet of critical theory is that the questions of what issues to study and how to study them cannot be divorced from each other. It is therefore in order to ask: what connects hackers with critical theorists? Arguably, the common feature they share might be that, at least in the eyes of their respective detractors, they are both hopelessly out of date. This being due to their shared vulnerability to what is said to be modern fallacies. If this negative portrayal is momentarily accepted, if only for the sake of the argument, it allows me to draw a parallel between the two and put forward a proposal. Perhaps the apparent 'backwardness' of both hackers and critical theorists also allows them to offer fresh angles on the current world order, which, according to received wisdom, has become 'post-modern', 'non-modern', 'post-industrial', 'post-fordist', 'post-human' and what not.

The association between hackers and modernism has been elaborated upon by Sherry Turkle. Her pioneering ethnographic works about hackers and computer users have become standard references in academic discussions. A central argument advanced by Turkle in *Life on the screen* is that the development of computer technology is linked to a tectonic shift in episteme, from modernism to post-modernism. At one point, she claims that the Macintosh computer is an

'emissary of postmodernist thought' (Turkle, 1996, p.276). It signals the end of an earlier world of computing which had to be instructed by typing command lines. With the Macintosh computer, the users could interact with their computers through a graphical interface. She thought this development corresponded with the transition from a modernist culture of calculation to a postmodernist culture of simulation. While the former culture was captivated by the idea of piercing through the interface to find the 'calculating essence' of the computer, the latter knew better than to ask for anything lying behind the representations displayed on the screen. The new and allegedly post-modernist culture invited a plurality of co-existing perspectives which undermined the epistemologically privileged position which the modernist master-narrative had previously assigned to computer elites. Turkle admitted that calculation was still going on in the computer, but that it was no longer the important question to reflect over or to engage with (*ibid*, p.18). Although Sherry Turkle did not refer directly to Jean-Francois Lyotard, her attempt to connect information technology with post-modernism in this way is highly reminiscent of his ideas (Lyotard, 1984; for a critique: Cooper, 2002).

As for critical theorists, they have been characterized as outmoded 'moderns' by, among others, Bruno Latour. He does not condone the schematic division of moderns and post-moderns like Sherry Turkle. Neither would he let himself be associated with universal claims explicitly linking computer technology with an epistemic discovery that 'we have never been modern'. But the similarities between Turkle and Latour remain striking with regards the new way of looking at the world they both suggest. Both celebrate the destabilisation of old epistemological elites. Both assert that one of the delusions of these old elites was the idea that there exists a hidden reality under the surface of things which can only be accessed through philosophical reflection and the acquisition of specific knowledge:

> The tradition of the human sciences no longer has the privilege of rising above the actor by discerning, beneath his unconscious actions, the reality that is to be brought to light. (Latour, 1993, p.44)

Speaking from the perspective of the critical theory of technology, Graeme Kirkpatrick has engaged with the work of both Turkle and Latour. With regards Turkle, he questions her endorsement of the 'post-modern' graphical interface. He views this interface in the light of modernist art theory. The ideal advanced by the latter is self-reflexivity. Accordingly, modern art should display its own technicality. The underlying production process should be visible in the appear-

ance of the artwork. Thus a painting abiding to this ideal should not seek to conceal the texture of the brush strokes. To appreciate this approach requires prior knowledge on the part of the observer. In other words, a trait of modern art theory is that it assigns an epistemological privilege to one perspective over others (Kirkpatrick, 2003). Kirkpatrick claims that the outlook of modernist art theory resonates with the advocacy of hackers for free access to source code. Hackers typically argue that the user must be able to examine and modify the software being used. When denied such access by producers and vendors of proprietary software, then this will not only have detrimental effects for the user, but also for society as a whole. Pursuing this argument, Kirkpatrick points to proprietary software as a showcase of how strategies of concealment can be used to maintain hegemonic power. Aesthetics, here represented by the graphical interface of the computer, lend support to this kind of strategy. Conversely, technical reason, as personified by hackers, offers a means for resisting the powers-that-be. In sharp contrast to Latour, Kirkpatrick concludes that the key task for those engaging in social studies of science and technology today, is to bring to light asymmetrical structures of domination which reproduce themselves at levels which are not addressed in everyday discourse (Kirkpatrick, 2008, p.157).

My description of hackers and critical theorists as 'moderns' serves to highlight a shared, epistemological outlook. Of course, in the case of hackers, this epistemology is only implicit. In the case of the critical theorists, it is the centre of attention. A key tenet of this epistemology is that social action is framed within multiple constitutive frames, each working at different levels of abstraction (Cooper, 2002, p.162). In short, reality should be envisioned as layered and not a flat surface. This implies that reality does not reveal itself to our senses in an immediate fashion. We grasp it only through the mediation of concepts. It follows that we can only gain access to some levels of abstraction through the acquisition of certain knowledge/skills. This in turn leads to the privileging of some kinds of knowledge over others.

Although this may sound overly abstract, these epistemological claims are pivotal for, for example, the demands of hackers for public access to source code. In making these demands, hackers assume that what is found on the screen can diverge from what is actually going on in the centres of calculation behind it, in ways which matter both to the individual users and to society as a whole. Unless users have some means to examine the instructions guiding their computers, they will remain at the mercy of those who wrote these instructions. This statement invites the objection that gaining access to the source code only makes a

difference to those lucky enough to know how to program computers. Hence, an auxiliary assumption behind the demand for public access to source code is that hackers as a collective can reasonably claim to represent the interests of the majority of unwitting computer users. These are controversial claims, not to say utopian. This is not, however, the place to defend the claims above or introduce nuances. For now, it suffices to note the similar significance that hackers assign to their programming skills and the powers critical theorists attribute to philosophical reflection.

According to critical theory, a theoretical idea about the social whole is required in order to uncover historically embedded layers of reality. It is by acquiring such an elevated point of perspective through philosophical reflection that individuals can raise above their immediate, lived conditions. Thus they can catch sight of the social relations which otherwise would have remained imperceptible. One consequence of adopting this approach is a shift in focus. When looking at hackers, for example, the focus moves from the agency of the hackers to how their social actions are framed within society as a whole. Or, to put it differently, this theoretical approach seeks to uncover the always-already constituted subject position of the hacker. Take, for example, a firm such as Red Hat, the most well-known promoter of free software products and services. In organisational theory and in social movement theory, the term 'institutional entrepreneurship' has been coined to describe this unison of commercial interests and political activism. With a critical theory approach, the attention is on the limits of such a strategy and on the kind of questions which cannot be raised from the subject-position of the institutional entrepreneur. This is not to deny the importance of firms like Red Hat for propagating free software solutions in place of proprietary software. It is unlikely, however, that the managers of these firms will ask how the ills of proprietary software relate to the social whole of commodity relations. By saying this, I want to illustrate the kind of inquiries which follow when we open the toolbox of critical theory. The choice between different epistemological stances, just like the choice between different technological designs, contributes to rendering some aspects of reality more transparent, while others are left opaque.

The aim of the current thesis is to discuss what kind of epistemology and theoretical concepts are required in order to bring to light social asymmetries and antagonisms shaping the development of technology and technical expertise. The practices of hackers have proven to be a rich field for carrying out empirical investigations into these matters. In fact, this is the research strategy I pursued prior to producing this thesis. My first book, *Hacking capitalism: The free and*

open source software movement, can be seen as containing preliminary formulations of many of the perspectives further developed here. I begun writing the book after having befriended a hacker, several years before I applied for a PhD position. Partly, I wanted to make sense of the things that my friend had related to me about hackers. Partly, I wished to become acquainted with theories which could explain the world around me. It seemed as if these two lines of inquiry could be combined in support of each other. While proceeding in this fashion, I was asked to write another book, *Allt mitt är ditt: Fildelning, upphovsrätt och försörjning*. The focus was on the file sharing phenomenon which was growing rapidly at the time in Sweden. Both books were completed during my first year as a PhD candidate. In the following three years, I have found reason to revisit some of the arguments I make in this earlier work. My encounter with other research traditions within the STS field has compelled me to modify my way of thinking. I have become more aware of the importance of epistemological questions, even when discussing ordinary and concrete things, such as software licenses or computer architecture. The purpose of the current thesis emerged as this insight grew on me. This long process of discovery and the revision of my earlier ideas about hackers are documented in the four articles collected here.

The first article, 'Determining social change: The role of technological determinism in the collective action framing of hackers' is accepted for publication in *New Media & Society*. Here I ask what collective action might look like in a context where ideas about necessity are preeminent. Belief in technological determinism is widespread among hackers. I propose, however, that the determinist narrative is itself under-determined. The case with politicised hackers shows how contentious politics can be formulated from within a narrative about technological neutrality, expertise and progress. The possibility of articulating antagonism in an engineering environment is a theme to which I return in my second article, published in *Science as Culture* with the title: 'Misuser inventions and the invention of the misuser – hackers, crackers and file sharers'. More specifically, the issue I address here is how antagonistic relations can be conceptualised in a setting where the identities and interests of the purported antagonists are subject to perpetual transformation through invention. In other words, what theoretical concepts are required in order to render potential conflicts of interest visible in such a highly unstable environment? Different approaches to the same issue are taken in the two articles based on my case study in the Czech Republic. My third article develops a critique of the innovation studies literature. The presumptions made in this field are such that many levels of user invention are ignored by the typical innovation scholar, especially with regards

contentious politics. Entitled 'Free space optics in the Czech wireless community: Shedding some light on the role of normativity for user-initiated innovations', my third article has been accepted for publication in *Science, Technology & Human Values*. The final article expresses the same concerns but this time addressing constructivist STS theory instead. Under the title 'Reconstructivism versus critical theory of technology: Alternative perspectives on activism and institutional entrepreneurship in the Czech wireless community' this paper has been published in *Social Epistemology*.

With this introduction, I hope to give the reader some orientation concerning the four articles which constitute my thesis. The ambition is to render explicit ideas which have shaped the character of the papers, but which have not always been fully developed. In the following section, I will define the term 'hacker' in more detail. In the process I shall critically review some of the earlier literature about hackers. Thereafter, I shall present my main theoretical points of departure. At the centre of discussion will stand the commonalities and divergences between constructivist STS and the critical theory of technology. These relations have preoccupied me during recent years. Thereafter, I discuss the methods I have used when studying hackers. I take my methodological cue from Theodor Adorno's reflections about balancing immanent and transcendent critique when investigating a topic. The final part of this introduction outlines in more detail how the individual articles relate to each other and sets an agenda for further research.

Who is the "Hacker"

At the outset I need to say a few words about the key figure at the centre of my work: the 'hacker'. There are several, conflicting notions to be found in the academic literature about how to address this figure. Bearing this in mind what better place to start looking for a definition than the *Jargon file*, a widely recognised lexicon of hacker slang? The first entry for 'hacker' reads:

> A person who enjoys exploring the details of programmable systems and how to stretch their capabilities, as opposed to most users, who prefer to learn only the minimum necessary (*Jargon file*).

Three more entries follow stressing the hacker's aptitude for programming. In addition, some general characteristics expected of an individual claiming to be a hacker are described, such as enthusiasm, curiosity, and the like. While this might offer a point of departure, scholars studying hackers must not stop there. The definitions given by the hackers, here represented by the quote from the

Jargon file, are too closely intertwined with their internal turf wars, their concern with excluding 'wannabes', with morale boosting, and so on. To start with, I will note a minor problem with the definition of the hacker laid down in the *Jargon file*. It relies heavily on one specific technical practice, i.e. programming computers. With such a definition, it would be stretching it to call the people I am looking at in this thesis for hackers. My informants are primarily involved in building wireless networks and open hardware. This underlines Christopher Kelty's speculation as to why the task of defining hackers might be particularly challenging. The practice of hackers is all about introducing new entities into the world. That is to say, hackers create things which overturn existing concepts and established modes of representation (Kelty, 2008, p. 94).

A definition of the 'hacker' must therefore be conceived in such a way that it stays open-ended towards future developments. Open hardware is a case in point. This notion draws heavily from the methodologies and principles which were first worked out by free software developers. Many of the people now tinkering with hardware have a background as software engineers. Writing code and running it on home-brewed machinery are two sides of the same coin. Hence, the development of open hardware and free software overlap due to technical requirements and personal affiliations. A visit to any of the larger hacker conferences in Europe, such as FOSDEM in Brussels or Chaos Computer Club in Berlin, will provide an idea of the rapid expansion of open hardware projects in recent years. Furthermore, just around the corner is a new field of 'open source biology' (Hope, 2008). Arguably, these phenomena should be taken account of in a discussion about what hacking is.

A definition of the hacker which is not tied down to a single technical practice or technology can be found in the tradition of cultural studies. Hackers are interpreted here as one youth subculture among others. This approach has been put forward by Douglas Thomas (Thomas, 2002). The argument makes sense given the overlap existing between hackers and geek and fan subcultures. Cultural studies perspectives have a lot to contribute to the discussion of how to delimit the category 'hackers'. After all, subcultures are all about defining who belongs to the group and who does not. The comparisons offered by Thomas are valuable also because he stresses how the hacker milieu differs from most other subcultures. The identity of hackers is bound up with a practice rather than with a style. Thomas finds this to be of importance since it endows hackers with a greater amount of self-determination vis-à-vis external influences. In contrast, style-based subcultures are more easily swayed by commercial forces and are therefore less capable of resisting authority.

A common feature of many subcultures, and here Thomas makes no exception for hackers, is that their resistance tends to be understood in terms of a 'generational conflict'. Hackers are said to be rebelling against the authority of adulthood. I would not disagree that there are generational aspects to hacking. The stereotypical image of a hacker is a boy or a man in his early twenties. Nevertheless, the description of hackers as a youth phenomenon seems less and less valid the further we move away from the 1980s and the so-called 'golden age' of hacking. This is not only due to the aging of individual participants. Equally important is the progressive integration of free software development into professional life. A large majority of the contributors to free software projects are now working in the IT sector or are students on the verge of becoming computer professionals (Lakhani and Wolf, 2005). That Douglas Thomas fails to take this into consideration might be symptomatic of what has been traditionally a blind spot of the cultural studies approach, i.e. its neglect of the political economy. If the stress is placed on the generational aspect of hackers' resistance, then one will not take full measure of the stakes involved in the political struggles of hackers.

The reasoning above points to an alternative interpretation of hackers as a social movement. Two spokespersons of this perspective are Paul Taylor and Tim Jordan. I agree with them that there is much to be learned from social movement theory. An advantage of this approach is that it asks how hackers constitute themselves as a political subject and begin to act collectively. Inquiries of this sort become increasingly urgent the more hackers become entangled in struggles against new intellectual property laws, state surveillance and so on. I borrow extensively from social movement theory in two of my articles, 'Determining social change' and ''Free space optics in the Czech wireless community'. Nevertheless, I hesitate to put hackers on an equal footing with any other social movement, and I am unconvinced by the attempts of Taylor and Jordan to do so. In their writings they tend to focus on hackers with an overt political agenda, such as the Cult of the Dead Cow and the Electro-hippies. These groups belong to a faction within the larger constellation of hackers who sometimes go under the name 'hacktivists'. Some issues championed by hacktivists include gender equality, immigration rights and alter-globalization critique. In other words, much the same agenda as can be found in a politically schooled, leftist environment. There are places, for instance in Spain and Italy, where hackers and the anarchist movement are closely intertwined. Still, this is more of an exception than the rule. A case can be made for arguing that hacktivist politics is something deriving from an 'outside'. It does not capture the full spec-

trum of ideas which have grown from within the practices of hackers. An indication of this is the frictions which often arise between hacktivists and so-called 'techies', i.e. hackers who claim to be interested in technology for its own sake. This does not rule out that the latter can become politicised too. This can happen, for instance, in response to new intellectual property laws. However, this kind of political engagement has its own distinguishing features (Coleman, 2003). One risks losing sight of the specificity of hacker politics if pride of place is given to hacktivists, as opposed to politicised techies. The subcultural lens adopted by Douglas Thomas might therefore be more promising in registering the heterogeneity and contradictions of hacker politics.

Even more problematic is the proposition that hackers constitute a new class. McKenzie Wark claims that the hacker class stands in opposition to the vectorial class, in much the same way as the working class confronted the capitalist class in the past (Wark, 2004). I do not dispute the continued relevance of class analysis in a society where an ever larger section of the global population depends on a wage for its survival (Fuchs, 2010). A discussion about hackers can be fruitfully connected to the old question about the rise of a white-collar working class. For instance, Graeme Kirkpatrick has observed that the moral panic over hackers in the mass media started in the 1980s. It was at this time that the class composition of the computer profession begun to change. If computer programming had previously been a resort for the upper middle class, the spread of home computers meant that a growing section of the working class could now become involved (Kirkpatrick, 2004).

My problem with Wark's perspective is not that he uses class analysis, but that he does so exclusively from an abstract, theoretical point of view. He says very little about the people calling themselves 'hackers' and the subjective side of class formation. What needs to be explained, in my opinion, is the discrepancy between, on the one hand, subjective experiences of belonging to a class, and, on the other hand, objective class determinations. This is particularly pertinent in the case of hackers, since their self-image largely stems from college life, fan subculture, amateurism, and, sometimes, entrepreneurial aspirations. In other words, settings not firstly associated with wage earning and corporate organisation (Liu, 2004). This outsider identity seems to become increasingly out-of-sync the more free software development becomes integrated into professional structures. Andrew Ross was one of the first to argue that hacking should be seen in the light of labour conflicts. I have explored this idea in some of my previous writings (Ross, 1991; Söderberg and Dafermoes, 2009; Söderberg,

2009). I doubt, however, that much insight can be gained from interpreting hackers as a new class in their own right.

My main objection to Wark is that the everyday life of hackers hardly ever enters into his theoretical reasoning. The opposite problem is common in descriptive works about hackers. A number of well-researched books have been published in the wake of the success of the free software movement (Benkler, 2006; Moody, 2001; Weber, 2004). These tend to be written by academics who sympathise with ideas about information freedom. My reservation with regard this genre is that the self-representations of hackers are reported by the scholars down to the point that the exclusions, omissions and so on made by the former are faithfully reproduced by the latter. A case in point is the definition given in the *Jargon file*. Hacking is here presented as if it was all about writing software, resulting in an exclusion of practices classified as 'cracking'. While free software development is closely associated with positive values such as information sharing and transparency, the hacker subculture is just as much about secrecy and stealth. My basic claim is that the definitions provided by the people calling themselves 'hackers' cannot be accepted at face value. The definitions put forward by them, just as much as the terms circulating in the mass media, are the outcome of conflicts and negotiations. The benevolent, lawful free software developer is highlighted in order to improve the tarnished, public image of the hacker. These negotiations feed into the larger political struggles which hackers are involved in, concerning intellectual property laws, net neutrality and so on. It is not hard to see, then, why many academics want to contribute to the improvement of the public image of hackers.

The thrust of my argument so far has been that 'hackers' should be defined in a loose and open-ended fashion. The definition cannot be reduced to a single technology and related technical practices, such as writing free software code. I have hinted at the need for a definition which takes account of a shared culture. Reversely, however, the specificity of the hacker vis-à-vis other groups would be lost, if all references to technical practices were abandoned. Indeed, the words 'hacking' and 'open' have often been used indiscriminately. An example of this is when artists and activists involved in 'culture jamming' claim to be doing a kind of hacking. Against these claims, I believe that some connection to technical practices must be maintained. This is crucial if one is to make sense of the strong, meritocratic values of hackers. Being skilled is the central axis by which hackers distinguish themselves from lammers, n00bes and AOLers, to mention a few of the dismaying epithets for ordinary computer users. Furthermore, hacking does not concern just any technology. Otherwise, hackers could not be

separated from tinkerers and inventors at large. There must be a connection, however remote, to practices relating to infrastructures for information processing. A concrete example hereof is the hackers developing so-called 'open cars', such as OSCar and C'mm'n projects. On the face of it, their practices might not be all that different from what goes on in a motor club. Crucially, though, these development projects are linked to adjacent hacking activities. They are inspired by the methodologies used in free software development, and they subscribe to the same moral codes, such as the centrality of information sharing.

The definition I am myself drawn towards comes close to what has been proposed by Christopher Kelty. On the one hand, his ethnographic work suggests that there is a particular hacker or geek identity shared by people in many places around the world. He recognises that scholars need a concept for addressing this commonality. On the other hand, he is aware of the pitfalls of categorising such a heterogeneous collective which, to make matters worse, is always in the process of becoming something else. He evokes the notion of a 'public' to wed together these conflicting points of consideration. The concept of a public is sufficiently vague to include an unspecified number of diverging phenomena, while, concurrently, being coherent enough to allow for collective action. It is in its role as a counter-balance to power that Kelty finds parallels between the eighteenth century public and the present one. While the old public was tied to the spread of coffee houses and the news media, among other things, the public which is now emerging builds on free software, open network standards, and the like. He speaks of the latter as a 'recursive public'. Through this, Kelty wants to stress that this public is geared towards defending/expanding the conditions of its own existence. Crucially, this takes place simultaneously on a discursive level and on the level of infrastructure. The notion of 'recursion' captures well the apolitical 'techie' who has become politicised in response to new intellectual property laws. Defending the legal and technical infrastructure required for writing software is a way of sustaining the hacker community, and, in the last instance, ones own existence as a hacker.

There are also some areas where I have problems with Christopher Kelty's account. I do not agree with his decision to abandon the word 'hacker'. He argues that the term has become too loaded with connotations about subversiveness and/or criminality. Thus he prefers to use the word 'geek' instead (Kelty, 2008, p.35). I disagree with this choice for the following reason: the people in question still refer to themselves as 'hackers'. To them, at least, the meanings invested in this word remain pertinent. A second reason for sticking to the term hacker is that it foregrounds technical practices more than the term

'geek' does. Finally, I do not think that the notion of a recursive public exhausts the problems encountered when trying to define the figure of the hacker. It cannot do justice to, for instance, the element of labour conflict which becomes more pronounced as free software development is integrated into corporate structures and professional life. Aside from these differences, Kelty's reasoning about the 'geek' is close to my understanding of the 'hacker'. With this term I am referring to a loose constellation of people who share similar ideas and values, ultimately anchored in certain kinds of technical practices. These technical practices must in one way or another relate to infrastructures of information processing. Despite being heterogeneous and perpetually changing, the shared identity of hackers is verified in that they from time to time can act as a concerted, political force. In other words, they constitute a 'recursive public'. This public is recursive in the sense that it tends to act in response to threats to the infrastructure upon which it depends.

Between Constructivist STS and Critical Theory

In this thesis, the relationship between technology and politics is investigated through studies of the practices of hackers. I approach the relationship by drawing upon a range of theoretical traditions. For the sake of orientation, I will indicate some of the sources of inspiration which have, directly or indirectly, contributed to my reasoning. A turning point for me was to encounter the theoretical-political writings of authors like Slavoj Žižek, Jacques Rancière and Chantal Mouffe. In their own distinct ways, these authors have protested against a post-political social order. They have affirmed the continued relevance of the concept of antagonism for philosophical reflection. In addition, various strands of Marxism have enriched my writing at different stages. A non-exclusive list would include labour process theory, Autonomist Marxism and Open Marxism. Social movement theory, especially where it touches upon questions of epistemology, has been another source of inspiration in my work. However, the two theoretical traditions which my thesis leans most heavily on are critical theory and constructivist STS. In order to provide a concise and balanced summary of my intellectual journey, I will restrict the following discussion to a comparison between the latter two schools. Ideas from other theoretical traditions mentioned above will be brought in as a supplementary resource.

The relation between critical theory, on the one hand, and constructivist STS theory, on the other, has been a major theme throughout my research. I will elaborate upon this relationship by looking more closely at three authors who have engaged with the STS literature from a critical theory perspective. Most

renowned among them is Andrew Feenberg who advocates a synthesis between the two schools, something he calls 'critical constructivism'. He has been supported, and, on occasions, opposed, by Graeme Kirkpatrick and Simon Cooper. All of them believe that an updated version of critical theory can form the epistemological foundations for STS inquiries. Such a proposal is conceivable, Feenberg argues, since many theoretical and methodological concerns are shared by the two traditions (Feenberg, 2008). I wish to address these similarities while seeking to clarify what remains hard to reconcile between critical theory and constructivist STS. In one sentence, this is the dialectical heritage of the former which clashes with the post-structuralist influences of the latter. In particular, a key sticking point between the two traditions is the concept of 'totality'. What political strategies follow from either maintaining or abandoning this concept? It is from the point of view of the social whole that critical theory claims to be able to transcend the horizons of the individual actors themselves. In other words, this philosophical idea is the key for engaging in ideology critique and for guiding praxis. An example of ideology critique, alluded to in the introduction, would be to develop a theoretical understanding which renders visible social conflicts and struggles which are mediated through science, technology and technical expertise. By elaborating upon these theoretical and normative concerns, I hope to explicate the thoughts which have been an undercurrent throughout my thesis work.

Andrew Feenberg's engagement with the STS field is in line with the work initiated by his former mentor, Herbert Marcuse. Unlike most of the other members of the Frankfurt School, possibly with the exception of Walter Benjamin, Marcuse showed a sustained interest in technology. Furthermore, Marcuse was at one point crowned as the guru of the May 1968 student movement. When the other members of the Frankfurt School withdrew from political life, Marcuse gave his, albeit qualified, support to the protesters. In short, Marcuse's thinking provides a good starting point for a critical theory of technology. The objective of such a research programme, Feenberg says, is to lend support to what he calls 'democratic rationalization'. By this he means user-interventions which challenge the undemocratic power structures embedded in modern technologies. He stresses the possibility for individuals engaged in technically mediated activities to actualise ambivalent potentialities suppressed by the prevailing technological rationality. An incomplete list of issues which are subject to contestation in this fashion include ecology, the quality of work and gender equality. He envisions an updated version of critical theory which can support such instances of collective action mobilised around new technologies.

In order to proceed, Feenberg argues that, the theories developed by the members of the Frankfurt School need to be updated. A renewed critique of technological rationality must restore the idea of agency. On this point, he finds that the tradition of critical theory falls short. In Max Horkheimer and Theodor Adorno's *Dialectic of Enlightenment*, critique of technology turns into a denunciation of modernity as such. Instrumental rationality and domination are said to be at the very heart of modern technology. Herbert Marcuse was more hopeful about the possibility of putting up resistance. Still, he shared his colleagues' bleak analysis about science and technology. Equally negative judgements were circulating at the time among conservative critics of modernity. The substantivist philosophy of Martin Heidegger and the civilization critique of Jacques Ellul became particularly influential. They took aim at the commonsensical understanding of technology as a neutral tool. This point of view is flawed because it fails to see the transformative role of technology in reconfiguring subjectivity and the lifeworld. Against the naive, instrumentalist viewpoint, the philosophers insisted on what they considered to be the substantial consequences of modern technology. The human subject can not be taken for granted as they have already been transformed by the technology they use. Under the influence of technology, everything and everyone becomes a resource and an object of technical control. Feenberg says that the members of the Frankfurt School provided a modified version of this civilisation critique, what he calls 'leftist dystopism'. He is unhappy with this direction as:

> […] absolute opposition to technology leaves no room for practical criticism and reform (Feenberg, 1999, p.128).

Much the same conclusion has been drawn by Graeme Kirkpatrick. He asserts that an updated critique of technology inspired by critical theory must first overcome its romantic vestiges and its suspicion towards technology (Kirkpatrick, 2004, p. 14). Their respective programmes for renewing critical theory grant greater significance to the agency of users intervening in technological designs. They do so, however, in different ways. Kirkpatrick's reasoning is influenced by American pragmatism, as is suggested by occasional references to John Dewey. Kirkpatrick speaks out in favour of the pragmatist point of view against substantivist philosophy which he finds a bad influence on the thinking of the Frankfurt School (Kirkpatrick, 2008, p.52). I will not dwell on this except to point out that Kirkpatrick's pragmatism places him closer to constructivist STS than he might think. In contrast, Feenberg has more in common with the first generation of critical theorists in that he validates their philosophical heri-

tage. Concurrently, however, he is more appreciative of constructivist STS thinking and actively encourages a rapprochement.

Constructivism is a richly branched tree and a few words are in order about what it entails. Ian Hacking identifies as the core postulate of constructivism (or what he labels 'constructionism') that things which look inevitable and eternal could have been different, and possibly better. Hence, whether it is stated or not, there is a moral agenda behind insisting on the contingency of a given outcome (Hacking, 1999). Methodologically, constructivist researchers rely on empirical observations when reflecting over science and technology. This course of action is sometimes spoken of as 'empirical philosophy'. When science and technology are approached through case studies, it becomes evident that technology can be many things and be given shifting meanings. This provides a corrective to the tendency among philosophers to contemplate technology from the comfort of their armchairs, and, as a consequence, treat it as a single monolithic entity. Andrew Feenberg is attracted to the empirical philosophy of constructivism because it secures a space for users to intervene in technology. Meaningful political work can be done on the level of individual design solutions. This possibility is jeopardised anew, however, if the constructivist argument is pushed too far. Then, the basis for its own critique disintegrates. Speaking of Actor-Network Theory, Feenberg warns that its anti-essentialist demand for permanent contestation of every totalizing discourse, down to the very notion of the human being, provides no basis for a positive project for reforming science and technology (Feenberg, 2002, p.30-32). The same concern has been expressed by Graeme Kirkpatrick (Kirkpatrick, 2008, p.106), and, indeed, by Ian Hacking (Hacking, 1999, p.95). Andrew Feenberg sees strengths and shortcomings with both substantivist philosophical reasoning and the case study approach prescribed by constructivist STS theory. He believes that it is possible to combine the best of the two worlds. A synthesis, which he labels 'critical constructivism', is thinkable because of the common roots of the two traditions. Although not all constructivist STS scholars are aware of it, Feenberg argues, their perspectives largely stem from Marxist ideas (Feenberg, 2008, p.14).

Indeed, there is a link between, on the one hand, the sociology of knowledge, and, on the other, Marxist ideology critique. It goes back to the forerunners of both traditions, Karl Mannheim and Georg Lukács. The two knew each other from having attended the same seminars in Hungary. Mannheim was influenced by the latter to the extent that he has been called a 'bourgeois Lukács'. Thematically, of course, they address the same questions about how to differentiate, if at

all, between scientific truth claims and ideology (Bailey, 1994; Lichtheim, 1965, p.187). Various additional Marxist strands have contributed to the thinking which later metamorphosed into the STS field. One source of influence, described by Gary Werskey, was the British scientific left in the 1930s. It consisted of a group of scientists and historians of science who began to historicize the scientific revolution. The growth of science was set against the backdrop of emerging, capitalist relations. In the 1970s, a new inflow of ideas came from the radical science movement. As a result of their political engagement, its members re-envisioned the history and politics of science shaping the intellectual heritage of the STS field (Werskey, 2007). Given these connections, it is not surprising to find overlaps between constructivist STS and the critical theory of technology. A case in point is the concern with 'empirical philosophy', which, in fact, was foreshadowed by the Frankfurt School. In his inaugural lecture, Max Horkheimer underlined that:

> [...] the philosophical questions themselves are dialectically integrated into the empirical scientific process; that is to say, their answers are to be found in the progress of substantive knowledge which also affects the form. (Horkheimer, 1989, p.32)

This methodological point is made against a common enemy of both constructivist STS and critical theory, i.e. contemplative philosophy. Empirical investigation is endorsed as an antidote to the inclination of many philosophers for *a priori* reasoning. Constructivist STS and critical theory also share an aversion to scientism. Writers in both traditions have been unsparing in their critiques of commonsense beliefs in scientific truth claims. Constructivist STS shares the determination of critical theory to expose reified concepts. The notion of 'reification' was developed by Georg Lukács. It describes the process by which received knowledge, such as scientific facts and laws, come to appear as eternally and universally valid. Against such perceptions, both constructivism and critical theory have insisted on focussing on the historical processes through which the facts in question are produced. Furthermore, both contend that this process is open-ended towards the future. The reason is that the validity of a fact or law depends on the intervention by the surrounding world. This leads on to an elevation of practice as a key consideration in writings about epistemology. However, although both schools appear to agree about this, the word 'practice' is subject to different interpretations. When the STS scholar Annemarie Mol emphasises the importance of studying practices, she is advising her colleagues to study the physical movements, routines, instruments, and so on, of the practitioners in a situated context. Conclusions about politics can follow from this

orientation. For instance, Mol ends her book about medical practices in a hospital by making some policy recommendations (Mol, 2002). For someone like Herbert Marcuse, on the other hand, practice denotes 'class struggle'. It is in this practice that the line between the world and knowledge about the world or, putting it differently, between object and subject, is transgressed (Marcuse, 1955).

From this example, it must be clear that the divergences between constructivist STS and critical theory are at least as significant as the commonalities. What interests me is not their political and normative differences *per se.* Rather, I am concerned with how divergent ideas about politics arise out of their different epistemological positions. This touches on an issue which not only separates constructivism from critical theory, but also separates the different camps within the constructivist STS tradition. It has to do with the special status of social theory. Or, differently put, how to delimit the field of inquiry of the constructivist programme. One camp, as is exemplified by the Edinburgh School, singles out the natural sciences as its object of study. The truth claims of the natural sciences are relativised by drawing upon the toolbox of sociology, and, occasionally, Marxism. Researchers subscribing to this school sometimes go under the label of 'social constructivists'. Another camp, represented by Actor-Network Theory (ANT), and its many variants, insists on removing the epithet 'social'. It does so while exclaiming that the social sciences must be subjected to the same kind of treatment as the natural sciences have been before. Generalisations about society and other 'social facts' cannot be relied upon any more than the truth claims uttered by the natural scientists. If social theory is held off-limits for constructivist analysis, the followers of ANT charge, then an implicit line will be re-established between nature and society (see the positions outlined in Pickering, 1992).

This move to extend constructivist analysis to include the social sciences has been made under the influence of a broader, intellectual current, namely, that of post-structuralism. A token hereof is that the constructivist STS scholars following this lead assumed the same destabilising consequences for the explanatory power of social theory (Zammito, 2004, p.165). Some notable thinkers associated with post-structuralism are Michel Foucault, Gilles Deleuze and Michel Serres. Although their writings are distinct, a few common themes within post-structuralist thinking can be discerned. These include a rejection of the possibilities for metaphysical closure and philosophical transcendence; a denial of universal truth claims; a critique of essentialism; a suspicion towards grand narratives, and, at times, an endorsement of post-humanism. That these postulates

clash with some core assumptions within critical theory will come as no surprise when recalling the origins of post-structuralism.

This line of thought grew strong in the wake of the 1968 student uprising in France. Characteristic of the post-68 intellectual milieu was its aversion to Hegelian philosophy and the Marxist currents it had inspired (Descombes, 1980). Another trait of this milieu was its preoccupation with totalitarianism. Such fears owed a lot to the Cold War rhetoric of the day. This gained in purchase among French intellectuals due to their personal experiences with the French communist party. These two aspects were wedded together, so that, bluntly put, the underlying cause of political totalitarianism was said to be Hegelian philosophy. Allegedly, the philosophy of Hegel was corrupt due to its penchant for logocentric metaphysical closure. To hold the threat of totalitarianism at bay, identified with 'dialectical thinking', intellectuals had to side with the fragmented, the heterogeneous, the local, the multiple and the immanent. In addition to concerns with transcendence were to be relinquished. Both as a philosophical idea and as a praxis, the notion of transcendence was said to end in a Leninist, vanguard party (Žižek, 2002; Christofferson, 2004).

This sketchy picture of the historical break between post-structuralism and Hegelian Marxist philosophy requires refinement. Much of the post-structuralist critique was foreshadowed by Theodor Adorno. Over the years, he had grown increasingly weary of the Hegelian vantage point from which the 'whole' of society allegedly could be rendered transparent. In its place, he came to emphasize 'negative dialectics'. Preeminence was given here to the individual phenomenon rather than any generalising concept. Unlike later-day writers associated with post-structuralism, however, Adorno never gave up all hope of radical transcendence (Adorno, 1990; for an assessment: Grumley, 1989, p.183). Adorno's rapprochement suggests that the distance between, for instance, Actor-Network Theory and some versions of dialectics, might be less than could have been expected (Söderberg & Netzén, 2010). Such ambiguities notwithstanding, it is clear that post-structuralism developed in opposition to Hegelian Marxist philosophy. My claim is that this juncture, where the common path of constructivist STS and critical theory divides, gives an indication of what remains hard to reconcile between the two. To whatever extent the postulates of post-structuralism have been passed down to constructivist STS, for instance, as regards its commitment to anti-essentialism and the notion of multiplicity, or its suspicion of so-called metaphysical closures, these ideas continue to ward against a return to dialectical thinking. In other words, we are confronted with

irresolvable differences between most schools of constructivist STS, including ANT, and the tradition of critical theory.

For the sake of clarity, I will limit my discussion to one vital point of divergence. That is, the disputed validity of the concept of 'totality'. My choice is partly motivated by the importance which Georg Lukács assigned to this notion. The decisive trait of Marxism, he famously declared, is the point of view of totality. It stands opposed to the atomist outlook of much bourgeois thinking (Lukács, 2000, p.27). Moreover, Martin Jay has argued that if there is any common denominator drawing together the heterogeneous bunch of authors collected under 'post-structuralism', it is their animosity towards this concept (Jay, 1984, p.515). I look more closely at this debate in my article 'Reconstructivism versus critical theory'. There I adopt a theoretical approach which investigates how the 'social whole of commodity relations' influenced the design of Ronja. In doing so, I relate to Adorno's defence of critical theory against empiricist sociology. In the latter tradition, concepts which cannot be verified through empirical research tend to be dismissed as speculative 'metaphysics'. Totality is precisely such a concept. And yet, Adorno contended, sociology cannot reject it without losing some of its explanatory power (Adorno, 1977, p.12). My discussion below is not, however, primarily concerned with the analytical merits of maintaining or abandoning the philosophical idea about a social whole. Instead, what I will discuss is how such a decision leads to contrasting political strategies.

The trend in academia and among activists during recent decades has been to adopt an epistemology voided from any reference to the concept of 'totality'. Andrew Feenberg observes, for instance, that politics is no longer understood as 'totalizing strategies of change'. Political action nowadays operates with more restricted, narrative claims (Feenberg, 1999, p. 104). He credits thinkers like Michel Foucault, Michel De Certeau and Bruno Latour for having led this reorientation towards 'micro-politics'. It is argued that social change should be achieved through a plurality of local struggles. Crucially, these struggles are supposed to unfold in the absence of a general strategy. They must not be subject to command by parties or unions. Graeme Kirkpatrick describes the same development in political thinking. He does not use the word 'micro-politics' and is negative in his overall assessment of Foucault and Latour. Still, his pragmatist re-reading of critical theory ends in a political proposal which in some respects is closer to them than to the associates of the Frankfurt School (Kirkpatrick, 2004, p.111-112). The main reason for this is that Kirkpatrick agrees with Latour about the superfluousness of what they consider to be 'metaphysics' and

'social substances' in critical theory (Kirkpatrick, 2008, p.110). Subsequently, Kirkpatrick sees little merit in a philosophical approach which envisions political change on a civilisational scale. Indeed, he criticises Feenberg for engaging in speculations of this sort. According to Kirkpatrick, these reflections are not needed in order to put forward proposals for reforming science and technology (Kirkpatrick, 2008, p.86). Feenberg maintains that substantivist philosophy has something to offer to present-day activists. Like Kirkpatrick, however, he is disappointed over the meagre political results of the Frankfurt School and its totalizing opposition to technology. Both authors are attracted to the empowering message which underlies the call to micro-politics. It ensures that changes can be made here and now, without having to take on a totality of social forces or waiting for the revolutionary moment. However, Feenberg also acknowledges the pitfalls of micro-politics. It is hard to see how a plurality of local struggles can measure up to a globally co-ordinated, political adversary, such as a state or a corporation (Feenberg, 2002, p.71).

Feenberg and Kirkpatrick are primarily concerned with securing a space for users to intervene in technology. A third perspective is provided by Simon Cooper who criticizes Feenberg for placing undue stress on the autonomous capacity of the social actor. Simon Cooper locates himself closer to the substantivist end of the spectrum. He draws upon Martin Heidegger in order to shift the burden of proof. Instead of speaking about the agency of the user, he focuses on how this subject position has always-already been transformed by the development of science and technology. It is for this reason that he doubts whether much can be achieved through a democratization of science and technology. It is thinkable, he argues, that the progress of science and technology will result in an inhospitable future even if the decisions have been taken democratically. He is not opposed to democratic reforms of science and technology. Rather, Cooper's argument is that critical theory must attend to problems which cannot be resolved through deliberation and user participation alone (Cooper, 2002; 2006). The problem Cooper runs into is a familiar one. When the subject position has been undermined in this way, no foundation remains for mounting resistance. Feenberg is quick to point out that Cooper fails to propose anything by which the current state of affairs could be improved upon (Feenberg, 2006, p.190).

I find Cooper's reasoning persuasive but also the concerns of Feenberg. Perhaps a fresh angle on this thorny issue can be provided by referring back to Theodor Adorno's defence against the accusation of defeatism. His argument

points to the link I am trying to establish between the philosophical idea of totality and opposing political strategies:

> The appearance of quietism can easily arise because the difficulties of change naturally stand out far more clearly if one has the whole of society in view. They are less prominent – and this again is a kind of pragmatism – if they are seen as within the scope of individual constellations, where structural relationships appear far more moderately and less harshly than in a theory of social structure. (Adorno, 2000, p.28).

Theodor Adorno went on, asserting that a praxis which relates to the total structure of society, and not merely to isolated social phenomena, would require a theory of society as a whole. The opposite standpoint is upheld by those constructivist STS approaches which subscribe to post-structuralism. They profess that the isolated social phenomenon – the individual case study – is all there is. This procedure was once dubbed 'methodological internalism' by Karin Knorr-Cetina and Michael Mulkay. It is exemplified by the early laboratory studies which championed a methodological approach exclusively focusing on local practices (Knorr-Cetina & Mulkay, 1983; for criticism: Doing, 2007). Unsurprisingly, when reflection over structural relationships has been suspended in this way, agency and micro-politics show up everywhere. According to the same line of thought, what confines the autonomous capacity of social actors is not structures, but rather writings where the existence of these underlying structures are affirmed. It is along these lines that an older generation of activist-minded STS scholars was taken to task by a row of constructivist writers. A case in point is Marc Berg's polemic against human-computer interactive design, something I look at more closely in my article on misuser inventions. As Luc Boltanski has shown in a different context, the turn towards empirical, micro-sociological investigations of practitioners themselves was a general trend in the 1980s. It emerged as a revolt against an earlier generation of sociologist-critics who had acted as omniscient sages vis-à-vis their informants. In hindsight, the trend of placing the focus exclusively on the informants' own experiences has turned out to be something of a political dead-end. Boltanski argues that an effective critique of society needs to be anchored in the perspectives of the actors but must then adopt an overarching point of view which transcends their restricted horizon (Boltanski, 2009, p.46, 58).

It is not unwarranted to be concerned that a political outlook starting with the philosophical idea of 'totality' will end up in defeatism. My conclusion is that

this risk must be accepted nonetheless. As is suggested from the discussion above, the alternative can be even worse. Furthermore, I believe that the ideas of the Frankfurt School can be interpreted in such a way that the risk for defeatism is limited. It depends on where one chooses to place the emphasis. Unsurprisingly, in the field of the critical theory of technology, the emphasis has been on how science and technology were discussed by the first generation of critical theorists. A key reference is Horkheimer and Adorno's *Dialectic of Enlightenment*. Its totalizing civilization critique can be read as converging on Heidegger's dreary judgement over modernity. Indeed, many have arrived at such an assessment, also thinkers who otherwise sympathize with the Frankfurt School. It would be too large an undertaking to go through the critical reception of *Dialectic of Enlightenment*. Let it suffice to say that I agree with an interpretation which offers the benefit of doubt to Horkheimer and Adorno by stressing their reason for writing in the first place, i.e. to make an appeal for social change (Zuidervaart, 2007). This is not an interpretation advanced by any of the three critical theorists discussed here – Simon Cooper, Andrew Feenberg and Graeme Kirkpatrick. They differ in their assessment of the heritage of substantivist philosophy. The first two appreciate the contribution of Heidegger's phenomenology to critical theory, while the third writer wishes it away. All three of them, however, devote a substantial amount of space to Heidegger, while Horkheimer and Adorno are only ever mentioned in passing. None of them deal in any great detail with the differences between the German philosopher and his Marxist contemporaries. One would think that Horkheimer and Adorno deserve a place of their own in a reinvented critical theory of technology. When it comes to Herbert Marcuse's version of critical theory, it makes more sense to treat it as an outgrowth of Heidegger's phenomenology. After all, Marcuse used to be a student of Heidegger (Feenberg, 2005).

If one adopts a version of critical theory analogous to Heidegger's contemplative critique of modernity, then there is a clear need for modifying that picture with a more empirically grounded approach to the study of science and technology. The case study approach prescribed by constructivist STS offers a corrective. Another candidate might be the down-to-earth outlook of American pragmatism. A third option would be to declare, with Marcuse, that now when the writings of the young Marx and their Hegelian roots have become known to us, we have no need for Heidegger anymore. This is the position developed by John Abromeit. He argues that Marcuse later in life succeeded in breaking free from the influence of Heidegger. If we are to believe John Abromeit, the mature works of Marcuse draw exclusively from Marx and Hegel (Abromeit, 2010).

I have nothing to add to the philological aspects of this debate. I do see, however, advantages with choosing the latter path when developing a critical theory of technology. Such an approach could focus on the epistemological and methodological reflections handed down to us by the Frankfurt School. These ideas could then be applied to contemporary studies of science and technology. A major issue in these texts is how the particular and material relates to the general and conceptual. In this balancing act, Adorno came out in defence of the richness of life which overspills the concepts that try to grasp it. This suggests, in other words, that in-depth, theoretical reflection must be conducted through empirical investigations. Depending on where one looks, the legacy of the Frankfurt School can just as well point to meticulously conducted case studies and surveys (Jay, 1974).

To sum up the argument so far, the current thesis aligns itself with a handful of writers who engage with the STS literature from the point of view of critical theory. Their individual differences remain to be worked out in detail, as do their respective stances towards the hitherto dominant branch of constructivist STS. Critical theory and constructivist STS have the same, historical roots. This can be seen from their shared interest in epistemological questions, their commitment to empirical philosophy, their critique of reified concepts and their focus on practice rather than contemplation. Nonetheless, I suspect that the dialectical thinking of the former and the post-structuralist influences of the latter cannot be easily accommodated within the same programme of research. This claim was developed by focussing on a sticking point central to the Hegelian Marxist tradition, namely: the concept of totality. I argue that this concept is irreconcilable with the core tenets of constructivist STS. This is due to the preference of constructivists for methodological internalism, an emphasis on multiplicity over wholeness and adherence to a flat/immanent ontology. In this thesis, I have tried to avoid these difficulties by looking for inspiration closer to the historical roots of critical theory. That is to say, closer to the Hegelian Marxist tradition, including some social constructivist camps within the STS field, such as the Edinburgh School and the social shaping of technology. My comparison has been chiefly concerned with the opposing, political strategies implied by these different epistemological stances. Much of it comes down to a question of the level of autonomy of the social actor. In constructivist STS, the capacity of users to intervene in science and technology is emphasized. The autonomous capacity of social actors looks more circumscribed in a version of critical theory which privileges the notion of a 'social whole'. The latter outlook is attentive to the always-already constituted subject position of the user. Al-

though the risk of defeatism is a real one, the risks with yielding all aspirations for transcendence are equally grave. Reflecting over how agency relates to the total structure of society is not to invalidate political engagement. On the contrary, it is a precondition for designing interventions capable of making a real difference.

Methodological Reflections Concerning Hackers

I shall now elaborate upon the theoretical perspectives outlined above in relation to the case of hackers. Philosophical reflection has come into play for me already through the initial decision of what to investigate. I decided to study hackers, and, in particular, those hackers who are building hardware equipment, in the belief that their practices offer an opportunity for investigating how antagonistic, political conflicts are mediated through technology and technical expertise. In making this argument, I have been inspired by the methodological pointers provided by the first generation of critical theorists. In particular, I draw on Adorno's idea of investigating a subject through a combination of immanent and transcendent critique. Immanent critique works from within the norms and standards of a given subject. In the case of hackers, their self-understanding and worldviews are taken as the starting point for analysis. The investigation then proceeds by exploring the internal contradictions of these accounts. Thereby the immanent critique is already in the process of transcending the limits of its object of study, i.e. the ideas of hackers. The investigation moves on to look at the conditions which the existence of a hacker culture presupposes. In a transcendent critique, hackers are studied from the point of view of a 'social whole' against which, and in relation to which, their ideas and practices are played out. Adorno's advice is that an analysis should proceed by alternating between immanent and transcendent methods (Adorno, 1995, p.31-33).

Indeed, it is an over-reliance on one of the two sides of critique which has led to my dissatisfaction with much of the existing literature on hackers. Some accounts go astray by taking the categorizations of hackers as givens. This is commonplace in descriptive works about the free software movement written by scholars who sympathise with its causes. The main problem with such work is that by failing to reflect theoretically over the self-descriptions of hackers, the scholars are unable to see much further than their informants. The problems start already with under-theorized definitions of the 'hacker'. In public life today, the hacker is firstly associated with computer crime and intrusion. This

picture is contested by many hackers for whom the word designates a creative attitude to technology. To them, hacking is more or less synonymous with free software development. However, as I write in the *Science as Culture* article, the counter-narrative of some hackers is no more reliable than the tales told in the media. The negative image assigned to the figure of the 'hacker' in the media is here ascribed to the 'cracker' and 'script-kiddie' instead.

It is for this reason I opt for a tentative and inclusive definition where 'hacker' applies to a broad range of cultural phenomena. As was previously discussed, I follow Christopher Kelty in striving for a definition which is sufficiently open-ended to include adjacent activities belonging to the same collective, such as the movement around file sharing, the activists building wireless computer networks, and open hardware developers. What might be lost in precision with this more inclusive definition will hopefully be gained by the fact that it does not divide up activities which are related to each other. For instance, the act of writing 'benevolent' free software code and the act of writing 'malicious' cracking tools. Indeed, my key point in the *Science as Culture* article is that this division between benevolent and malicious uses of technology should not be allowed to delimit the scope of the inquiry in advance. Not to be caught inside given boundaries, the scholar must adopt a perspective which overarches the worldviews and self-understandings of the hackers.

Then again, examples abound where the testimonies of hackers are confuted from an elevated, theoretical horizon. Some issues which have disturbed academic commentators include the predominance of male hackers, a penchant for liberal or libertarian worldviews and a faith in technological determinism. In my article for *New Media & Society*, I take issue with the negative estimations of the technological determinism of hackers. I too find that technological determinist explanations of social change can be found wanting. What I remain unconvinced about, however, is the connection repeatedly drawn in the academic literature, between an erroneous belief in technological determinism and anti-democratic, entrenched power relations. I started to have doubts after I had witnessed one episode in the Swedish media debate about file sharing. Spokespersons for the Swedish Pirate Party as well as many of its supporters in the 'blogosphere' have frequently referred to the inevitability of technological change (Andersson, 2010). When new laws on intellectual property have been passed by parliament, proponents of file sharing argue defiantly that these laws will soon be circumvented thanks to the development of information technology and the free flow of information. In reaction to such declarations of faith in technological determinism, the representatives of the culture industry came out

in defense of the possibility of politics to overcome the imperative of technological necessity. Leaving aside the comic qualities of such exchanges, they suggest that academic critics have been wrong in ascribing an underdog position to whoever is challenging technological deterministic viewpoints. This is not to say that the objections against the male chauvinism, liberal ideology or technological utopianism of hackers are ill-founded. Such depictions, however, tend to be rather predictable. What risks being foreclosed is a sensitivity for how established meanings are subverted in the practices of hackers. As a consequence, the contradictory and possibly emancipatory potential of hacking is left unexplored. More can be learned if the hackers are judged on their own terms.

Although Gabriella Coleman and Alex Golub do not refer to immanent and transcendent critique, their work offers a good example of the kind of approach I have in mind. They have studied the liberal/libertarian convictions of hackers without buying into this worldview or foreclosing its potentialities. Coleman and Golub argue that the contradictory tendencies within liberalism are selectively adopted by groups of hackers. Hence, it is by no means automatic that libertarian hackers will end up in league with the *status quo*. On the contrary, the liberalism of hackers is often on collision course with existing, liberal societies (Coleman & Golub, 2008). This argument attests to a general feature of hacker politics, namely: the extent to which it is 'under-determined'. Another indication of the same thing is that both the political left and right are in two minds about what to make of free software licenses or file sharing. To be honest about my own allegiances, I am sympathetic to the ideas expressed by hackers in relation to, for instance, their demands for free access to information. However, my stance towards them resembles Theodor Roszak's when he positioned himself vis-à-vis the 1960s counterculture. In the opening chapter of his pioneering study, he felt obliged to defend his undertaking against anticipated criticism. The counterculture is not the best thing we could have wished for, he conceded, but it is what we have left to work with (Roszak, 1996 [1969]). This statement is no less pertinent for hackers today. While the influence of the radical ideas of the 1960s is steadily receding, a new kind of political engagement is mounting around hacking. The contradictory potentialities of hackers' ideas and practices need to be examined, if only because they may be the only thing we will have to work with in future. A theoretical and methodological approach is therefore called for which stays alert to the ambiguities of hacker politics without becoming subservient to its goals. It can be found, I believe, in the dictum of combining an immanent critique with a transcendent critique. This, in turn, points in

the direction of combining philosophical reflection with empirical investigations.

The main empirical work in this thesis is my study of the Ronja project. This case study is based on a six-month period of fieldwork in the Czech Republic. When I arrived in Prague in autumn 2008, I discovered that the project was in decline. My hope of following practitioners when they were building Ronja machines was thwarted. Instead, most of my work consisted in tracing the connections between the people that had been involved in the project. In total, I interviewed twenty-one of the developers and users of Ronja. Most of the interviews lasted for about two hours. The main developer of Ronja and the leader of the competing project, Crusader, were interviewed on more than one occasion. I held my interviews with developers and users not only in the Czech Republic but also in Slovakia, Sweden, Holland and Switzerland. Using Skype I also interviewed a developer in India. In addition to my interview material, I gathered information about the project through web-based mailing lists, discussion forums and homepages. Fortunately, the construction manual for the official Ronja design has been made available in English. I have not been as fortunate with the documentation connected to unofficial and modified versions of Ronja which have circulated in the Czech wireless network community. Likewise, with few exceptions, the discussions which have taken place over the Internet concerning Ronja have been in Czech and Slovak. Reading these texts has been time consuming, given my rudimentary grasp of the Czech language, and this has prevented me from charting everything that has been going on. However, combining my interview material with the significant amount of written documentation I have been able to decipher, I have managed to derive a fairly comprehensive picture of the rise and fall of the Ronja project.

Some words need to be said about the discrepancy existing between my method of choice, and the argument I'm attempting to advance through this case study. A central claim of mine is that Ronja technology has been shaped by forces stretching beyond the builders and users of the technology and their immediate circumstances. To be more precise, the course of the Ronja project was influenced by the social whole of commodity relations. Market forces have intervened both in the design of the technology, and in the lives of its users and producers alike. This claim is contrary to Michel Callon's idea about the performativity of markets (Callon, 1998). He believes that markets are performed locally. This idea resonates with the dictum of 'methodological internalism' discussed above. It affirms the sovereignty of the locally emergent over any 'social whole'. Arguments to this effect are typically advanced through case

studies. This choice of method corresponds with the content of the argument. Scholars who remain unconvinced about the ideas of Callon et. al. remain as consistent when they turn to statistics and comparative methods to make contesting claims. Not so when I adopt a case study arguing against the idea of the performativity of markets. I am prepared to introduce a mismatch between the method I draw upon and the claims I make. The weight of my argument is carried by the observations made at the site of investigation. But my argument is that these observations retain their meaning only through the mediation of a web of social relations framing the individual site of the case study.

The classic objection against the case study method applies to me in full, since, unlike my interlocutors, I have accepted some of the premises behind that critique. Joseph Pitt formulates this objection by talking about the two shortcomings of case study methods. The first shortcoming emerges when the case has been selected for the sake of exemplifying a philosophical point. In this instance, these philosophical claims will not be sufficiently supported. It could be argued, says Pitt, that the empirical data was collected with this purpose in mind. When the case study instead is taken as the starting point of the inquiry, problems arise in relation to the second major shortcoming. No philosophical direction will emerge out of such a chaotic mass of data (Pitt, 2001). It is the first shortcoming identified by Joseph Pitt which my argument is at risk of falling victim to.

A well-known defence of case study methodology has been advanced by Bent Flyvbjerg. Bringing him up here is relevant also because his defence is part of a larger programme for making social science matter which I am in accord with. His goal is to heighten the political relevance of sociological research. This requires that sociology abandon the ideals of the natural sciences and concentrate on what is specific about the social sciences. This leads Flyvbjerg to argue for research based on case studies focussing on the concerns of different groups and publics, value judgements and power relations. Crucially, Flyvbjerg acknowledges, and this resonates with my argument above, that the case study approach needs to incorporate an external measuring rod in relation to which the practitioners can be assessed (Flyvbjerg, 2008, p.94). In light of Flyvbjerg's defence of the case study method, I readily confess that my initial assumptions were to some extent mirrored in my empirical findings. Anything else would be inconceivable. The pressing question is rather whether or not the resistances I encountered during my study were able to modify my initial agenda and prejudices. This is a question, however, which must be posed with equal vigour to any other empirical research method. Flyvbjerg argues compellingly that the

case study is not *per se* any more or less subjective than a systematic testing of hypotheses through large surveys and statistics. The prestige of the latter hangs together with the ideal of prediction, emulating the methods of the natural sciences. Since that ideal has been shown to be something of a pipe dream, a more realistic aspiration would be to initiate learning processes. In this way the case study can be privileged as didactics has demonstrated the centrality of cases for the capacity of humans to learn.

Flyvbjerg's argument has bearing on my study of the Ronja project. Although, in the end, I claim to have confirmed many of my initial suppositions through my case study, I encountered things along the way which I could not have anticipated in advance. One example hereof is that the motives of the contesting groups of the Ronja community were much more multi-faceted than I had imagined. When following the debates on the mailing lists from Sweden, the dividing lines seemed to be rather clear-cut between, on the one hand, a group of politically motivated idealists, and, on the other, a group of pragmatically minded entrepreneurs. What I found in the Czech Republic was that the two main parties subscribed to rather similar political ideas. These ideas were fractured, however, by alternative approaches to disseminating the invention among ordinary users. From this experience they drew different conclusions about the possibility of achieving political goals through developing new technology. That a learning process was initiated through my case study is something I think can be seen from the differences in style between the two theoretical articles. The one about misuser invention was written before and the one about the technological determinism of hackers was written after I had completed my field work in the Czech Republic.

One might still respond to Flyvbjerg by asking what the relevance of learning through case studies is to others than those directly involved. His answer is that it could be of great importance, depending on how the case study is located in relation to general problems in the field in question. One example hereof is what he calls a 'critical case study'. Critical case studies deliberately seek out the toughest possible case for confirming or refuting some research question. Such a case should permit deductions of the type: 'If this claim is valid/invalid in this case, then it applies to all/no cases' (Flyvbjerg, 2006, p.230). Case selection is thus made to bear the full weight of Flyvbjerg's defence of the relevance of the case study approach. It is an argument I sympathise with, since it stresses the importance of the framing of the case and the theoretical reflections which necessarily have preceded the study. This is even more accentuated when Flyvbjerg moves on to discuss what he calls 'paradigmatic cases'. These are cases

which serve to highlight general features and trends in society. By way of illustration, he discusses how Michel Foucault extrapolated from the notion of the Panopticon to say something about society at large. Flyvbjerg acknowledges that the criteria for selecting paradigmatic cases are hard to pin down, as an element of personal intuition or sociological imagination will always be called for. He believes that an apt choice of case can nonetheless be recognised by peers (Flyvbjerg, 2006). What he is striving for with the notion of 'paradigmatic cases' is I believe possible to combine with Adorno's insistence that sociologists must study the essential. By this Adorno meant historically produced relations which manifest themselves in the movements of society as a whole (Adorno, 2000, p.25).

My determination to study the Ronja project, which, after all, required me to seek additional funding for my doctoral research and to learn how to read Czech, arose out of an intuition that this was a critical case, and, perhaps even a paradigmatic one. It was critical in the strict sense that it seemed to challenge the hypothesis I wanted to explore. A quick glance at Ronja suggested a locally emergent technology leading to the creation of a small market for a new device. During the initial years the Ronja project remained isolated primarily due to the fact that all the documentation and the discussions were in Czech. Furthermore, the ambition of designing the technology with locally available resources and skills was a guiding ambition of the project. The intended local self-sufficiency of the project was coupled with a strong desire to create a free space independent of established institutions, such as funding agencies and government authorities.

This last ambition is critical to the overall concerns of my thesis as I have been interested to investigate how the Czech wireless network community, though formally floating outside any bureaucratic control structures, is nonetheless enmeshed in a globally encompassing and historically developed 'form', that is: the commodity form. In other words, I wanted to reveal the always-already constituted subject position of Czech wifi entrepreneurs overlaying their individual views and aspirations. By definition, my analytical concerns could not be expected to show up in the statements of the actors themselves. What I found in the Ronja case, however, was that the community had been split in half over the question of the limits of institutional entrepreneurship. More specifically, it was disputed whether or not it was a viable, political strategy to redesign the invention into a full-fledged, consumer good. Thanks to this controversy, the spotlight was placed on the form as opposed to the content of the marketable product. Thus, I was able to collect testimony pointing to how the design of the

technology had been streamlined according to the requirements of the commodity form.

It is in this respect that the case in question can deserve the label 'paradigmatic'. The Ronja project foreshadowed the growth of a broader global movement around open hardware design which has just begun to emerge in recent years. This movement seems to be indicative of a more general trend, where the development of technology is taking place 'outside' firms and professions. It then becomes essential, in Adorno's sense of the word, to examine how the seemingly autonomous activities of users and entrepreneurs are nonetheless gravitating towards the circulation of new kinds of commodities and ways of making a living in a market economy. Ultimately, with this case study I hope to have given further weight to the argument that social analysis needs to incorporate an awareness of a social whole of commodity relations. It points to the restricted autonomy and self-understanding of social actors, and, by extension, the limits of the case study approach.

Structure of Thesis

This thesis consists of four articles, all of which deal with hackers in one way or another. The first article, 'Determining social change', commences by highlighting the technological deterministic viewpoints of many hackers and sometimes, of scholars studying hackers. Since I also subscribed to this position when I embarked on my research, this article can be said to trace my own intellectual development. Under the influence of constructivist theory, I have been sensitized to the politically negotiated constructions underlying claims about 'nature' and 'necessity'. While becoming acquainted with this argument, however, I remembered why I had been attracted to the slogan of many hackers that 'information wants to be free' in the first place. It asserted that the demands for free access to information were destined to prevail despite the entrenched political and economic forces working against such a development. It was for this reason that I began to question some of the key assumptions behind the academic debunking of technological determinism. For example, the assumption that subscription to a technological determinist viewpoint is incompatible with a genuine concern for democratic involvement. Having recently acquired the constructivist toolbox, I decided to apply it to this last vestige of necessity. My basic proposition, then, was as follow: the meaning of deterministic explanations is under-determined too. What needs to be explained is why the link be-

tween technological determinism and undemocratic attitudes continues to be taken for granted. I propose that there are political reasons for this.

My claim can be illustrated with reference to the work of John Law. In a recent paper, Law (2009) developed a defence of the kind of intellectual position that I am implicitly questioning in my article about determinism. He is dedicated to the task of deconstructing grand narratives about science (technological determinism, universally valid truth claims and so on). He abstains, however, from taking sides in any of the narratives he has deconstructed. That would presumably lead to a new metaphysical closure. John Law insists that his intellectual position is nevertheless progressive and relevant. The condition for making that claim is that the link between determinacy and undemocratic values is being kept fixed. An unremitting critique of grand narratives will therefore necessarily land on the side of democracy, without asking for any further political commitments on the part of the science studies scholar (Law, 2009). The counter-claim, that narratives about technological determinism are under-determined, points us in the opposite direction. In order to be politically relevant, science studies scholars must take sides and contribute to some grand narratives. By having turned constructivism upon itself in this way, I have also turned it upon myself, and demonstrated how much of my thinking nowadays is indebted to this mode of reasoning.

To be more specific about the content of the *New Media & Society* article. My argument is advanced by making a historical comparison between hackers and the labour movement. In both cases, ideas about technological necessity have been incorporated into their demands for democratic reforms. It is not only technocratic policy makers, then, but grassroots activists too, who may claim the apolitical, neutral high-ground in public debates. If my argument went no further than this, however, it would lead only to a celebration of the capacity of the 'underdogs' to subvert and appropriate dominant meanings. What I want to highlight is rather the limits for thematizing political conflicts in a society preoccupied with technical problem solving and consensus building. On the one hand, this rhetorical strategy is effectively deployed by hackers, while, on the other hand, unknown horizons have been foreclosed by the near impossibility of articulating politics in outright, antagonistic terms.

Similar concerns infuse my second article, 'Misuser invention and the invention of the misuser: Hackers, crackers and file sharers', which is published in *Science as Culture*. There I refer to the work of Chantal Mouffe, Slavoj Žižek and Jacques Rancière, among others, who have returned to the conservative legal scho-

lar Carl Schmitt in search of an alternative to the self-understanding of liberal and pluralistic societies. A post-political situation is upon us, they argue in their own distinctive ways, because of a general refusal in society to recognise antagonistic conflicts. My contribution in the article consists in bringing this concern with post-politics into contact with current discussions about user-centred innovation and lay expertise. I direct attention to aspects of user involvement in technology which have been insufficiently researched and where antagonism stands out, for instance, lay expertise in cryptography. Examples like this one are tested against the theoretical challenge to the concept of antagonism developed by Marc Berg and other like-minded, constructivist STS scholars. Taking a cue from what is known as the 'interest debate', Berg questions the plausibility of speaking about antagonistic relations between workers and managers in a factory. This idea has become outdated, he claims, because the identities and interests of the antagonists have been rendered fluid and contingent by the introduction of new technology. No antagonists can be discerned in the perpetual reconfiguration of human-machine hybrids.

As should be clear from my reasoning above, I do not share the post-structuralist and post-humanist premises behind Berg's reasoning. Still, his objection contains an important element of truth. Technology is not merely suppressing existing conflicts of interest. Technology can be developed in such a way that potential conflicts of interest are anticipated and dispersed before they have been thematized as such and come to existence. However, if there are no stable identities or interests against which antagonistic struggles are being played out, how can one tell if there is a conflict of interest at all? It is at this point I find it useful to return to Carl Schmitt. The punitive side of law enforcement gives a clear signal of an asymmetrical power relation and interests in conflict. This is not to say, however, that legal sanctions offer any immediate access to the existence of antagonistic relations. Antagonism will only be seen if one first refuses to let the legal system decide in advance who is the user and who is the misuser. It is for this reason I insist that these categorisations must not be taken as received knowledge. If they are, studies of user-centred invention will proceed according to a 'container theory' approach, where users who are defying the law are discussed in a completely different fashion to those who are not. In this way, the presence of antagonistic relations disappears from view once again. Indeed, this is exactly how hackers, crackers and file sharers have been divided up in much of the academic literature, even though these people often use the same programming tools and belong to the same recursive public.

The third and the fourth articles collected in this volume are based on my study of the Ronja project in the Czech Republic. Here too, my concern is to defend an epistemology which renders visible aspects of user involvement and lay expertise. I believe that these aspects tend to be missed out in the two dominant theoretical approaches, innovation studies and constructivist STS. The third article, 'Free space optics in the Czech wireless community', accepted for publication in *Science, Technology and Human Values*, engages in a polemic against innovation studies. My argument emerges out of a critique which constructivist STS scholars have already launched against work in the innovation studies tradition. Briefly stated, the typical study of user-centred innovation is conceived in relation to the concerns of the firm benefiting from the activity of the users. Subsequently, these studies tend to be framed by an impoverished understanding of the participants as users/consumers with ready-made, fixed needs. The underlying assumption is that the incentive for users to innovate stems from the fact that their needs have not yet been satisfied by the existing products on the market. What is missing from this is the generative and dynamic aspects of needs/desires. Such an objection can be made from the position exemplified by Marc Berg above. Needs, just like interests, should be seen as contingent moments in an ever-changing network of human/machine hybrids. I reach a similar conclusion but building on social movement theory instead.

I argue that technical inventions should be seen as by-products of the formation of a collective, political subject. When the process is framed in this fashion, the inquiry comes to centre on the processes of meaning creation and the field of the 'social'. It is at these levels of abstraction that one can make sense of the generative and dynamic aspects of user communities. The relevance of a social movement perspective for understanding user-centred innovation is suggested by the Ronja case. The political aspirations of the main developers were constitutive of the community, and, subsequently, the inventions stemming from it. For certain, I also found many involved – perhaps a majority – who had built Ronja machines merely to get cheap and fast connectivity, and for whom the politically charged aspects of the project leader appeared vacuous. These individuals seemed to comply well with the vision of the user found in a typical innovation studies article. In my article, I argue that the centrality which these people ascribe to technical functionality, needs satisfaction and price were not common to all users. In part, it was due to the failure of one group within the community to mobilise the remaining users in support of the political vision of freely shared, open hardware. This partially explains why the practice of sharing hardware designs between developers could not be maintained. This contri-

buted to a stalemate in the development process and the dissolution of the group. In hindsight, performance and price appear as crucial factors shaping the fate of the Ronja project, while the other rationales for developing the technology have largely failed to leave their mark.

The final article, 'Reconstructivism versus critical theory', has been published in *Social Epistemology*. My focus here is on users as they have been conceived in constructivist STS. I argue that activism and entrepreneurship in the Czech wireless network community cannot be adequately framed as a locally emergent and agency-driven phenomenon. A fuller account would have to include EU regulations on competition, state allocation of frequencies for wifi traffic, the global supply chain of consumer electronics, the expansion of the higher education system, and so on. Crucially, these entities are not just 'scaled-up networks' as Bruno Latour would have us believe (Latour, 1983). My counter argument is that it is insufficient to follow material connections alone in this fashion. These empirically observable traces must be seen as folded into historically developed forms which constitute reality on multiple levels of abstraction (cf. Cooper, 2002). Asserting this is not to dispute the validity of the case study approach. I have chosen to address the Ronja project because it brings into relief a deviant case compared to how technologically advanced hardware equipment is usually developed, i.e. by professionals working for firms or universities. Hence, the Ronja project is a useful case for highlighting the importance of the 'social whole' of commodity and wage labour relations in shaping the design of technology. Such an analysis could not have been made without the theoretical concepts which I mobilize and defend in my study.

The four articles collected in this volume may also be seen as groundwork for studies I am interested in pursuing in the future. The Ronja project was a forerunner of a now rapidly emerging movement concerned with open hardware development. Several attempts are underway to create a definition of 'open hardware' and specify what kind of legal protection such projects will need. The ambition is to guarantee the same freedoms of distributing, examining and modifying hardware products as is already the case with free software. Although the definitions and legal specificities remain vague, several open hardware projects are gaining momentum. Currently, I am investigating the development of an open source 3D-printer known as *Rep-rap*. This project was initiated in 2004 and global interest in it has rapidly escalated in the last two years. At the moment there are more than 3000 participants around the world building and experimenting with this machine. The printer extrudes plastic instead of ink and thus 'prints' physical objects. The aim of the project is to design the machine in

such a way that it can print out most of the parts required for its own replication. I am interested in studying this project because it may again be possible to consider critical and paradigmatic in the rise or fall of a new open hardware movement. If the manufacturing process offered by a 3D-printer became widely available for home use, it would potentially enable a growing number of people to initiate and contribute to other open hardware projects. I expect to find many parallels between the Ronja project and the Rep-rap project. Both cases promise to throw light upon questions of expertise; how the division of labour is reintroduced between different classes of users; which design solutions can render the technology more or less transparent and how political visions are either sustained or extinguished through the development of new technologies.

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Sammanfattning

Inledning och syfte

Framgångarna för den fria mjukvarurörelsen har inspirerat åtskilliga andra att överta de metoder, språkbruk och synsätt som brukar förknippas med hackers. Bland annat håller en ny rörelse på att växa fram som ägnar sig åt att utveckla öppen hårdvara. En föregångare till denna rörelse var de aktivister i Tjeckien som under de första åren på 2000-talet byggde trådlösa nätverk. Sådan verksamhet pågick på många håll runt om i världen vid den här tiden. Dock utmärkte sig de Tjeckiska aktivisterna eftersom de hade uppfunnit en egen teknologi för ändamålet. Teknologin, som de döpte till Ronja, bestod i en apparat som använder synligt, rött ljus för att sända data. Genom att montera apparaterna på hustaken kunde aktivisterna koppla upp sina datorer med varandra. Under ett par år erbjöd Ronja den billigaste, snabbaste och mest robusta lösningen för att bygga trådlösa datornätverk som fanns att tillgå i Tjeckien. Utöver det behov som teknologin uppfyllde fanns en politisk vision bakom projektet. Utvecklarna hoppades att Ronja skulle bidra till spridningen av trådlösa datornätverk som kontrollerades av användarna själva. Målet var att motverka en allt mer statligt reglerad och kommersiellt driven infrastruktur för datorkommunikation. Detta kan stå som exempel på hur politiska ambitioner omsattes i utvecklingen av en teknologi. Erfarenheterna och föreställningarna hos de Tjeckiska aktivisterna är min utgångspunkt i avhandlingen. Dessa erbjuder en ingångsvinkel för att diskutera relationen mellan teknik och politik. Syftet med avhandlingen är att undersöka denna relation. En central frågeställning är vilka teoretiska begrepp som behövs för att synliggöra asymmetrier och antagonismer på teknologins och den tekniska expertisens område.

Teoretiska utgångspunkter

Mina resonemang i avhandlingen hämtar inspiration från ett flertal teoretiska strömningar. De två skolbildningar som starkast präglat avhandlingen är kritisk teori och konstruktivistisk teori. Relationen mellan dessa två skolor har upptagit en stor del av mitt intresse under arbetets gång. Det fåtal tänkare som diskuterat konstruktivistiska teorier om teknik och vetenskap utifrån ett kritisk teoriperspektiv har därför spelat en viktig roll för mig. Mest känd bland dessa är Andrew Feenberg. Han har förordat en sammanslagning av de två teoribildningarna, något som han döpt till ”kritisk konstruktivism”. Feenberg har argumenterat för att en sådan korsbefruktning är möjlig tack vare att de bägge traditionerna delar ett gemensamt ursprung i Marxistisk ideologikritik. Han menar att detta borgar för ett likartat synsätt på flera områden. Exempelvis förespråkar anhängare av respektive teoribildning att filosofi ska bedrivas genom empiriska studier. Ordet ”empirisk filosofi” har myntats för att beskriva ett sådant tillvägagångssätt. En näraliggande slutsats som delas av bägge skolorna är att vägen till kunskap går via praktiker och studier av dessa snarare än genom kontemplation.

I min jämförelse förutsätter jag denna samsyn för att bättre kunna fokusera på de skillnader som jag menar består. Även dessa skillnader kan härledas till de två teoribildningarnas gemensamma historia. Närmare bestämt kan de spåras tillbaks till efterdyningarna av maj 1968. En ny generation av tänkare bröt med den då på många håll dominerande Hegelianska och Marxistiska idétraditionen till vilken kritisk teori hör. Den nya tankeriktningen som tog vid sammanfattas ibland med termen post-strukturalism. De konstruktivistiska skolor som anslutit sig till denna intellektuella trend har anammat ett par antaganden som är svåra att förena med kritisk teori. Det skulle krävas en omfattande utläggning för att belägga mitt påstående. Här kommer jag att nöja mig med att lyfta fram ett enda filosofiskt begrepp som skiljer kritisk teori från mycket konstruktivistisk teori. Inom den filosofiska tradition som kritisk teori ansluter sig till står begreppet ”totalitet” i centrum. Samtidigt är förkastandet av detta begrepp en gemensam nämnare för den brokiga skara av tänkare som brukar associeras med poststrukturalism. Många konstruktivistiska teorier sluter upp bakom ett sådant ställningstagande. Istället föreskriver de studier som uteslutande lyfter fram lokalt situerade fenomen. Karin Knorr-Cetina har kallat det senare tillvägagångssättet för ”metodologisk internalism”. Konsekvenserna härav, både analytiskt och praktiskt, är vidsträckta. För att min framställning ska vara överblick-

bar begränsar jag den fortsatta diskussionen till de politiska följderna av att anamma alternativt överge begreppet ”totalitet”.

Den centrala uppgiften för kritisk teori är att vägleda politiskt handlande genom att utveckla ideologikritik. Möjligheten att bedriva sådan kritik vilar på antagandet om en historiskt uppkommen, samhällelig totalitet. Det är nämligen utifrån denna teoretiska utblickspunkt som kritiska teoretiker gör anspråk på att kunna värdera de praktiker och de erfarenheter som återfinns i det platsbundna sammanhanget. Enligt detta synsätt ger informanternas egna verklighetsbeskrivningar en otillräcklig grund för att bygga en normativ kritik på. Historiskt sedimenterade, strukturella ojämlikheter kan ha blivit allmänna till den grad att dessa strukturer inte längre är synliga för informanterna själva. Därav vikten som kritisk teori lägger vid att medvetandegöra de samhälleliga krafter som förmodas verka bakom aktörernas ryggar. Kontrasten är skarp mot förhållningssättet som exempelvis teoretikern Bruno Latour påbjuder. En av hans mest berömda deviser är att sociologer bör ”följa aktörerna”. Med detta talesätt vill han ställa aktörernas praktiker och erfarenheter i förgrunden. Även detta ideal har politiska förtecken. Det antas underminera övertaget som vissa grupper tillskansar sig, till exempel sociologer som bedriver ideologikritik, när de utger sig för representera någon annan eller tala utifrån en högre princip eller ett vetenskapligt sanningsanspråk.

Med respektive epistemologiska ställningstagande följer olika och delvis motsatta idéer om vad som kan och bör göras. Inte oväntat finns det nackdelar med bägge synsätten. En risk med den hållning som föreskrivs av kritisk teori är att det leder till politisk handlingsförlamning. Om varje enskild situation överskuggas av en samhällelig totalitet kommer handlingsutrymmet framstå som mycket litet. Det är denna risk som bekymrar Andrew Feenberg. I motsvarande grad attraheras han av konstruktivistisk teori och det handlingsutrymme som här tycks öppnas upp. Ett vanligt, konstruktivistiskt argument gör gällande att till synes eviga och universella sanningsanspråk i själva verket vidmakthålls genom lokala praktiker. Implikationen härav är att förhållanden som verkar evigt rådande och universellt giltiga likafullt kan upphävas genom att de lokala praktikerna modifieras. Risken som jag ser med att förkasta begreppet ”totalitet” och ansluta sig till det senare förhållningssättet är att känslan av politisk handlingsfrihet köps alltför lättvindigt. Att teoretiskt reflektera över de strukturerande processer och sammanhang som begränsar aktörens utrymme står inte nödvändigtvis i motsättning till politiskt engagemang. Tvärtom, det kan vara en förutsättning för att handla verkningsfullt.

Detta nedslag i avhandlingens teoretiska resonemang är mycket begränsat. Inte desto mindre hoppas jag att det fångar ett genomgående tema i avhandlingen. Alla fyra artiklarna behandlar på ett eller annat sätt relationen mellan kritisk teori och konstruktivistisk teori. Min genomlysning av deras likheter och skillnader är påkallad av avhandlingens syfte, det vill säga, som ett led i diskussionen om vilka teoretiska begrepp som behövs för att tematisera asymmetrier och antagonismer på teknologins och den tekniska expertisens områden. Beroende på var tonvikten läggs kan arvet från kritisk teori peka mot ett empiriskt tillvägagångssätt som ligger nära aktörernas praktiker och utsagor. Ett sådant förhållningssätt stämmer överens med insikten i konstruktivistisk teori om att filosofi bör bedrivas genom empiriska undersökningar. Ett närmande mellan kritisk teori och åtminstone en del strömningar inom konstruktivismen, till exempel de som arbetar i Edinburgh-skolans efterföljd, är fullt tänkbar. Dock finns det också djuplodande skillnader mellan kritisk teori och vissa läger inom den konstruktivistiska tanketraditionen. Att vara på det klara med dessa skillnader är viktigt eftersom de olika teoretiska utgångspunkterna leder till olika och delvis motstående slutsatser om vad som kan och bör göras.

Empiri och metod

Ambitionen att bedriva filosofisk reflektion genom empiriska studier ligger till grund för min avhandling. I min empiri tittar jag på hackers. Några ord behöver därför sägas om vad jag menar med ”hacker”. Termen är omstridd och det finns flera olika användningar i den akademiska litteraturen. Jag lutar mig här mot en inkluderande definition av det slag som tidigare har förordats av Christopher Kelty. Han medger att det finns en stor spännvidd av idéer och praktiker men yrkar ändå på existensen av en förenande identitet. Den ligger inte i utvecklingen av en specifik teknologi (exempelvis fri mjukvara) utan i gemensamma föreställningar och värderingar hos hackers. När dessa idéer kommer till uttryck i kollektivt politiskt handlande blir det meningsfullt att tala om dem som en enhetlig rörelse. Jag skiljer mig från Kelty i det att jag lägger större vikt vid de tekniska praktikerna. Delvis är det därför som jag väljer att tala om ”hackers” medan Kelty föredrar ordet ”geek” även om vi i stort sett refererar till samma grupp av datoranvändare. Kopplingen till tekniska praktiker behövs för att förklara det som är specifikt med hackers, exempelvis det starka, meritokratiska idealet eller föreställningen om teknikutvecklingen som en samhällsomstörtande och huvudsakligen positiv kraft.

Teknikdeterminismen som många hackers ger uttryck för har blivit till en måltavla för akademisk kritik. De politiska anspråken hos hackers har även ifrågasatts med hänvisning till dominansen av män bosatta i industrialiserade länder och tillhörandes ett privilegierat samhällsskikt. Dessa invändningar är inte obefogade. Dock riskerar kritik av det här slaget att förbise den potential till samhällelig förändring som också finns inneboende i rörelsen kring hacking. Vad jag efterlyser är en känsla för hur de praktiker som hackers bedriver kan förskjuta etablerade kategoriseringar och meningssammanhang. Jag vill hävda att denna möjlighet tas tillvara på ett bättre sätt i Theodor Adornos utfästelse om en ”immanent kritik”. En sådan kritik bedömer aktörernas utsagor på deras egna villkor. Samtidigt strävar kritiken mot att utforska de inre motsättningarna i dessa utsagor. Undersökningen siktar in sig på avvikelsen mellan utsagorna och de faktiska praktikerna. Därmed rör sig studien bortom aktörernas egna utsagor och mot de bortre gränser som aktörerna förutsätter. Den immanenta kritiken slår över i en transcendental kritik. Här ställs aktörerna mot ett utifrån uppställt ramverk. Adornos poäng är att en fruktbar kritik måste växla mellan de två strategierna. Detta tillvägagångssätt har varit vägledande i min studie av hackers.

Det huvudsakliga empiriska materialet i avhandlingen utgörs av min fallstudie av Ronja-projektet. Jag tillbringade sex månader i Tjeckien under hösten 2008. Tyvärr upptäckte jag när jag anlände till Prag att projektet hade gått i stå. Därmed grusades min förhoppning om att bedriva deltagande observationer på folk som konstruerade sina egna Ronja-apparater. En stor del av mitt arbete bestod istället i att spåra upp användare och utvecklare som hade varit involverade i projektet i ett tidigare skede. Sammantaget gjorde jag tjugoen intervjuer i Tjeckien, Slovakien, Nederländerna, Sverige och Schweiz. Över Skype intervjuade jag ytterligare en utvecklare som var bosatt i Indien. Intervjuerna var semistrukturerade och varade i cirka två timmar. Utvecklaren av Ronja och ledaren för ett konkurrerande projekt, Crusader, träffade jag vid ett flertal tillfällen. Utöver intervjumaterialet fanns en stor mängd dokument om projektet tillgängliga på Internet. En del text fanns översatt till engelska, till exempel instruktionerna för hur man bygger en Ronja-apparat. På diskussionsforumen, mailinglistorna och webbsidorna hade projektet diskuterats flitigt på tjeckiska och slovakiska. På grund av mina begränsade språkkunskaper har jag sannolikt inte till fullo kunnat tillgodogöra mig materialet. När de skrivna dokumenten och intervjuerna läggs samman ger det ändå en enhetlig bild av förloppet för Ronja-projektet.

Artikel ett

Den första artikeln är accepterad för publicering i *New Media & Society* och heter ”Determining social change: The role of technological determinism in the collective action framing of hackers”. I artikeln tittar jag närmare på de föreställningar om teknologisk determinism som cirkulerar bland hackers. Akademiker som skrivit om hackers har ofta reagerat negativt på dylika idéer. Inom den akademiska litteraturen sätts ibland likhetstecken mellan en tro på teknologisk determinism och apolitiska eller rent av icke-demokratiska värderingar. I denna artikel utforskar jag hur hackers artikulerar sin politik inifrån en sådan berättelse om teknologisk determinism. I all korthet är min hypotes att också påståenden om determinism är under-determinerade. Min argumentation grundar sig i en jämförelse med hur arbetarrörelsen i början på nittonhundratalet åberopade nödvändigheten av en historieutveckling som skulle kulminera i socialism. Från 1960-talet och framåt växte föreställningen fram om ett antågande, postindustriellt informationssamhälle. Denna berättelse lånade mycket av de deterministiska dragen från den tidiga arbetarrörelsen. En skillnad var att myten om informationssamhället huvudsakligen åberopades av politiska och ekonomiska eliter. Framtiden som utlovades var först teknokratisk och sedan, från 1980-talet och framåt, allt mer marknadsliberal. När samma idé övertas av hackers idag kvarstår de deterministiska undertonerna. Men denna gång pekar teknologiutvecklingen istället mot en nödvändig framtid av öppna tekniska standarder och fria informationsutbyten. En slutsats som jag drar i artikeln är att akademiska kritiker måste vara försiktiga när de fäller omdömen om, exempelvis, föreställningar om teknologisk determinism, eftersom begreppets innebörd kan skifta.

Artikel två

Den efterföljande artikeln är publicerad i *Science as Culture* och går under titeln ”Misuser inventions and the invention of the misuser: Hackers, crackers and filesharers”. Min forskningsfråga lyder som följer: hur kan man få syn på antagonistiska relationer i en miljö som ständigt förvandlas av nya innovationer och där parternas identiteter och intressen inte är stabila? Jag tar avstamp i Marc Bergs polemik mot en äldre teoribildning som studerade införandet av ny teknik på arbetsplatsen. Berg hävdar att forskarna som var verksamma inom detta fält tog miste när de förutsatte att det finns bestående identiteter mellan vilka en varaktig intressekonflikt utspelar sig. I artikeln accepterar jag Bergs utmaning att

försöka belägga existensen av antagonistiska relationer också där teknologiutvecklingen är som snabbast och som mest genomgripande. Jag föreslår att sådana konflikter kan sökas där användarnas uppfinningsrikedom bekämpas av rättsväsendet. Fildelning är ett paradexempel. Närvaron av en intressekonflikt framträder med önskvärd tydlighet genom de tvångsmedel som riktas mot utvecklare och användare av fildelningstjänster. Intressant att notera är att rättsväsendets åtgärder motarbetas genom innovation. Exemplen är många på hur lagstiftningen gjorts verkningslös genom uppkomsten av nya och mer decentraliserade metoder för att distribuera filer över datornätverket. Med andra ord är det inte så att föreställningen om antagonistiska relationer har blivit irrelevant. Tvärtom kan den högt uppskruvade förändringstakten med nya lagar och nya fildelningssystem tas som ett kvitto på en pågående, antagonistisk kamp. Denna strid utkämpas genom uppfinnandet av ny teknik, nya identiteter och förändrade spelregler.

Artikel tre

Den tredje artikeln, ”Free space optics in the Czech wireless community: Shedding some light on the role of normativity for user-initiated innovations” är accepterad för publicering i *Science, Technology & Human Values*. Artikeln baseras på fältstudien som jag gjorde i Tjeckien. Där ifrågasätter jag ett antagande som genomsyrar innovationsstudier. Forskare inom fältet brukar utgå ifrån att användare uppfinner nya produkter för att stilla behov som ännu inte kan tillfredsställas på marknaden. Detta antagande bygger på en idealtypisk användare som kommer färdigt utrustad med konstanta behov. Under min studie i Tjeckien mötte jag många som använt Ronja och vars motiv överensstämde med den bilden. De hade blivit attraherade till projektet eftersom det erbjöd dem den billigaste och bästa metoden för att bygga datornätverk. Flera av dem vittnade dock om att de gradvis utvecklat en relation till Ronja som gick långt utöver de tekniska funktionerna hos apparaten. Hos de mest inbitna utvecklarna var drivkraften av ett helt annat slag. De hade en vision om att sprida ett datornätverk som kontrollerades av användarna själva och som skulle kunna utgöra en motvikt till en statligt kontrollerad kommunikationsinfrastruktur. Om de hade saknat en sådan drivkraft hade de inte varit särskilt motiverade att fortsätta med utvecklingsarbetet efter det att de hade uppfyllt sina egna behov. En slutsats som jag drar i artikeln är att teorier om sociala rörelser kan utgöra en resurs för att förklara dynamiken bakom användardriven innovation.

Artikel fyra

Artikel fyra är publicerad i *Social Epistemology* och heter ”Reconstructivism versus critical theory of technology: Alternative perspectives on activism and institutional entrepreneurship in the Czech wireless community”. Här använder jag Ronja-studien som utgångspunkt för en jämförelse mellan kritisk teori och en variant på konstruktivistisk teori som kallar sig för ”rekonstuktivism”. Anhängare av denna teoribildning är missnöjda med vad de anser vara en brist på politiskt engagemang inom huvudfåran av konstruktivism. Grundantagandet om att världen är konstruerad bedömer de som sunt. De argumenterar för att denna insikt kan bli politiskt slagkraftig om frågan ställs hur världen skall konstrueras på ett bättre sätt. Vad jag vänder mig emot är att deras argumentation fäster så lite avseende vid hur de epistemologiska antagandena färgar de politiska strategierna. Jag utvecklar detta påstående genom min studie av Ronja-projektet. Fältstudien gav prov på hur designen av Ronja och designen av andra rivaliserande projekt formades av omgivande varurelationer. Detta resonemang förutsätter ett teoretiskt ramverk som godtar den filosofiska idén om en samhällelig totalitet (av varurelationer). Med andra ord, argumentet låter sig inte göras med en konstruktivistisk teori som uteslutande fokuserar på lokalt situerade fenomen. Både kritisk teori och konstruktivistisk teori kan understödja politisk verksamhet, beroende på hur denna verksamhet definieras. En sak som rekonstruktivisterna tar sikte på är riskerna med kommersiellt driven forskning och teknologiutveckling. I artikeln argumenterar jag för att om det är politik av det slaget som man vill bedriva så är de epistemologiska antaganden som återfinns inom kritisk teori att föredra.