

STI Studies

Science, Technology & Innovation Studies
Vol. 4, No 1, July 2008

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ISSN: 1861-3675

www.sti-studies.de

Editorial

Extending the scope of STI-Studies

During a very short period of time, the internet has changed the way of doing things in many areas of society. Nowadays we are accustomed to communicate, to order goods or do business via the World Wide Web. Only a decade after these processes took off, one can hardly imagine a world without computers and networks everywhere.

Three articles in this volume of STI-Studies explore these developments. Frank Kleeman, Günter Voß, and Kerstin Rieder analyze a new phenomenon named “crowdsourcing”, which has altered the roles of producers and consumers in internet-based businesses. Niels Taubert’s article deals with decision-making processes in open-source projects – a new mode of voluntary distant cooperation that only came about by the novel opportunities of the internet. Jörg Potthast asks for the new quality of digital media in controlling complex systems. In the fourth contribution Jörg Wullweber presents an analysis of nanotechnology-discourses, drawing our attention to another strand of technological innovation, which might revolutionize our lives as well.

STI-Studies is a product of the internet age, too. By utilizing the new opportunities of online publication we launched the “first internationally oriented, reviewed online journal for the German speaking STI community” – a description we have been using up to now as a kind of subtitle of the journal, indicating that a kind of self-imposed ‘provincialism’ could be helpful to get things started and to assist the German speaking STI community to get better access to the international scene.

However, the responses we received during the last years indicate that STI-Studies meanwhile has become a ‘normal’ journal which – thanks to the internet – generates requests (and article submissions) from all over the world.

This is why we are now going to change our editorial policy, opening the journal tentatively for contributions from authors outside the German speaking STI community. The next issues will show if we can balance these different objectives: maintaining and expanding an international orientation, guaranteeing high quality standards and – still important – providing a platform for a community that is on its way to get across the borders.

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Un(der)paid Innovators: The Commercial Utilization of Consumer Work through Crowdsourcing

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received 15 January 2008, received in revised form 15 May 2008, accepted 27 May 2008

Abstract

This paper investigates the phenomena of "crowdsourcing", or the outsourcing of tasks to the general internet public. This phenomenon was made possible by technological innovations associated with "Web 2.0" but is evidence of historically significant change in the relations between firms and their customers. We are witnessing the emergence of a new consumer type: the "working consumer". In the conventional role, consumers were passive "kings" to be waited upon. Consumers now are becoming more like co-workers who take over specific parts of a production process, whereby this process ultimately remains under the control of a commercial enterprise. This article seeks a more precise definition of crowdsourcing, catalogues some of its forms, and differentiates them from peripherally related phenomena. It ends with a discussion regarding potential consequences (negative and positive) of crowdsourcing for the future organization of work.

* The authors wish to thank Christian Papsdorf for research assistance and an initial typology of crowdsourcing and similar phenomena.

1 Introduction

Crowdsourcing, as argued in this article, takes place when a profit oriented firm outsources specific tasks essential for the making or sale of its product to the general public (the crowd) in the form of an open call over the internet, with the intention of animating individuals to make a contribution to the firm's production process for free or for significantly less than that contribution is worth to the firm. Firms engage in crowdsourcing to inexpensively mobilize the creative work of sometimes highly skilled persons as a resource for the generation of value and profits. Tasks that lend themselves to crowdsourcing include product design, advertising, quality monitoring, and the solution of specific technical problems.

Crowdsourcing has been made possible on a large scale by the emergence of "Web 2.0," a shorthand term for new internet applications that make two-way communication easier to manage. This article examines the phenomena of crowdsourcing in Web 2.0 and reflects on its ramifications for the organization of work and society.

The following section examines the wider context of change in corporate-consumer relations. The emergence of a new type of consumer, the "working consumer," is discussed as a theoretical preliminary for understanding the specific phenomenon of crowdsourcing. Reflections on a more precise definition of crowdsourcing are presented below (in section 3.1) together with an examination of the technical prerequisites (3.2) for its various types (3.3), with the caveat that it should not be conflated with related forms of interactive participation now common on the internet (3.4).

Voluntary participation in crowdsourcing tasks is currently very popular among internet users. Possible motivations driving individual participation and other factors that explain the rising prevalence of crowdsourcing, in-

cluding the motives of firms who initiate it, are discussed below (4). By way of conclusion (5), some potential future consequences of crowdsourcing for firms and consumers are reflected upon.

2 The Working Consumer

A functional differentiation of society into two dichotomous spheres of "production" and "consumption" is an artifact of early industrial society. The role of the consumer in this dichotomy is royally passive: consumers buy and use products, and that is all. Even in the act of buying they are waited on.

Self-service emerged much later in the history of consumption. Department stores in which customers were allowed to handle the stock themselves and vending machines first appeared at the end of the nineteenth century in the United States (Porter Benson 1988; König 2000). These changes reached Europe shortly afterwards and became widespread in the 1950s. Self-service first became commonplace in grocery stores, but by the 1970s companies like IKEA and fast-food chains widely expanded its use. Self-service principles started to become prevalent in many other areas of retailing like home improvement, pharmacy, and automotive supply at this time too.

Since the 1990s, the internet has been playing an important role in expanding forms of cooperation between firms and consumers in the production process. The internet revolution, which has left its "e-" footprint on many areas of the public sphere (e-government, e-commerce, e-banking, etc.), is not only about new technical possibilities of communication. Consumers are also being given increasing degrees of responsibility for service provision, e.g. in the health sector (Rieder 2005).

Considered in light of the history of industrial society, relations between firms and consumers recently have undergone far-reaching changes indeed. Consumers have ceased to be

merely passive takers of goods and services provided by company employees. Rather, they increasingly take part in firms' production and service delivery processes actively and directly. Consumers have become more like co-workers, who take over specific parts of a production process that ultimately remains under the control of a commercial enterprise.

Voß and Rieder (2005) interpret this development as the emergence of a new consumer type: the "working consumer" (*"arbeitender Kunde"*). The literal translation of "*Kunde*" is "customer," but the broader term "consumer" is more appropriate, because it encompasses a more complete range of relationships and conventions that define and regulate the firm's dealings with outside individuals.

Although consumer research has paid little attention to fundamental changes in corporate-consumer relations (cf. Scherhorn 1977; Rosenkranz/Schneider 2000), other research traditions began to draw attention to these phenomena in the 1970s. Three separate research perspectives have each separately investigated different aspects of the active participation of consumers.

Sociology and economics look at consumer behaviour as a part and outcome of larger social and economic transformations. Research into the tertiarization of the economy, coupled with the realization that the cooperation of consumers is often necessary for the provision of services, gave an important impetus for investigations of consumers' "coproduction" activities (Gross/Badura 1977; Gartner/Riessman 1974). Around the same time, feminists called attention to similarities between paid and non-paid work (Hausen 1978; Ostner 1978; Krell 1984). Active consumption became more and more widely investigated beginning in the early 1980s. One central term emerging at this time was "prosumers" (Toffler 1980), who are persons who consume what they produce themselves. Other concepts were

"do-it-yourself" work (Offe/Heinze 1990) and "the work of consuming" (Joerges 1981). Another core concept was "McDonaldization," first mentioned by Ritzer (1983), which is the rationalization of service routines whereby consumers are expected to perform certain essential steps.

Whereas sociology and economics focused on the linkages of consumer behaviour to broad social change, the management literature concerns itself with the practical matter of developing recommendations for firms dealing with the active consumer. As early as the 1970s and in the context of reflections on the transition to the service economy, a central question was how to integrate so-called external production factors (consumers in this case) into service provision and what risks were involved in doing so (Love-lock/Young 1979; Maleri 1994). Getting customers involved in production processes was an important issue also for manufacturing firms, for example in the widely touted concept of the "virtual corporation" wherein the focus was on business customers in particular (Davidow/Malone 1992). The consumer was discovered as a central resource for corporations, which were advised to treat "customer development" as seriously as personnel development (Gouthier/Schmid 2001; Gouthier 2003). One began to speak of "outsourcing to the customer" and even to think of customers as "service providers" (cf. Grün/Brunner 2002). Recent work conceptualizes consumers as joint participants with the firm in value creation (Reichwald/Piller 2006).

A third research tradition examines consumer behaviour from the perspective of role theory. Parsons (1951) pioneered this approach with his reflections on the complementary roles of doctors and patients. Using the "service encounters" approach of the management literature, researchers began looking at variation in consumers' active roles in various types of services (Czepiel/Solomon/Suprenant 1985;

Mohr/Bitner 1991). This research made clear that the quality of service provision depends just as much on how well consumers play their roles as on how well employees play theirs. Over time, both sets of roles were less often described as complementary and more often as similar. Consumers are thought of as "partial" employees (Mills/Morris 1986) or unpaid employees (Nerdinger 1994). Roles even come to be understood as interchangeable: "Employees as customers, customers as employees" (Bowers/Martin/Luker 1990). The importance of digital technology was often noted as a precondition for many new forms of self-service, as in the example of observations of services offered by mobile telecommunications companies. A "new type of prosumer" was discovered among cell phone service users, whose activities and skills are very similar to those of the information technology professionals who nominally provide those services (Hanekop/Tasch/Wittke 2001: 91; Hanekop/Wittke 2005). Other studies showed that consumers often do not have the skills one would expect of employees and that consumers are often confronted with unsatisfactory "working conditions" (Dunkel/Voß 2004).

It is characteristic of this literature that the active consumer is not treated as a subject in its own right but rather tangentially, by way of answering questions of internal significance to each of the individual research traditions. Voß and Rieder (2005) made an effort to overcome disciplinary boundaries in their review and synthesis of these separate literatures, summarizing their findings in what they call the *working consumer thesis*:

Firms are shifting a wide array of previously internal capacities and functions onto their own customers, consumers in general, and other non-employees. This trend is affecting an increasing number of areas and is being conducted increasingly systematically.

Currently, a pronounced increase in the instances of outsourcing to non-employees can be observed even as the forms and prevalence of self-service in all branches of commerce and industry are multiplying (Rieder/Laupper 2007). Examples are ticket machines and online ticket sales in public transportation, e-shopping and self-scanning in retail, and in the wide range of transactions in tourism, banking, and investment that individuals can carry out via the internet. All of these self-service activities cut firms' personnel needs – and related costs – significantly.

Yet the quantitative increase of outsourcing to non-employees is not as interesting as the qualitative changes it is bringing about. Indeed, we are witnessing a new phenomenon in the history of commerce and industry. Non-employees (customers, consumers, clients, patients, patrons, citizens, etc.) are fulfilling functions and providing capacities in the value creation process, usually for free. These capacities can be and are being exploited commercially. For instance, customers of amazon.com advise other customers by writing product reviews, uploading lists of favourite books, and rating the reliability of private sellers. More examples are discussed below.

On the basis of these empirical developments, one can speculate that the working consumer thesis implies a long-term, fundamental change in the social relations of production. What might these changes look like?

Possibly, "consumers" as we currently conceive them will simply disappear. The current notion of consumers arose in conjunction with industrialization and is characterized by the act of consuming *as opposed to* the act of work. In its place we may see a new, hybrid figure arise – that of the "working consumer" (Voß/Rieder 2005). Three characteristics of the working consumer that go beyond mere consumption are central to an ideal-typical definition: a) working consumers are

active in the production process and can be utilized as value-adding workers; b) the capacities they possess are valuable economic assets; and c) they are systematically integrated into corporate structures, where their actions can be monitored and manipulated by corporate managers much as if they were employees.

The examples of corporate outsourcing to consumers noted above may represent the beginning of wider changes in firm-consumer relations. Placed in macroeconomic perspective, we can speculate on the emergence of a new, expanded logic of the commercial exploitation of labour in the value creation process. Managers and investors are now beginning – explicitly and systematically – to tap into a new and previously untouched sphere of latent assets in the pursuit of profit. Of course, not every aspect of this activity is new. Corporations have always availed themselves of the capacities of workers whom they do not hold in their employ, as shown by many examples of home work. However, home workers were only indirectly influenced by the organization of the firm itself, if at all. New now is that firms are systematically building into their own strategic planning the commercial utilization of the productive capacity of persons who are completely outside the formal framework regulating corporate employees and suppliers. If one is so inclined, this development can be characterized as a further encroachment of capitalism into an area of social life that until now had been untouched by economic rationality.

One can postulate the beginnings of a new form of socialization of the individual through work, or rather through forms of unpaid or insufficiently remunerated work for firms in the capacity of a "consumer". In the future, people's identities may be influenced as much by these kinds of activities as they are now shaped by what they do in their regular jobs. In the place of the "long arm of the job," which reaches deep into the personal lives of employ-

ees, we may get two long arms: the arm of the job and the arm of consumer work. In the process, the corporation stands to obtain greater access to the capacities of workers than ever before, thus increasing the individual's dependency on corporate structures.

Corporations may also be affected negatively by these developments. The new kind of dependency emerging from changes in customer relations is not a one-way street. Corporations now depend on working consumers to carry out their "jobs" reliably and in accordance with the plans and needs of the firm. Thus, the rise of consumer work entails dangers and risks for both individuals and firms.

3 Crowdsourcing in Web 2.0

3.1 Towards a Precise Definition of Crowdsourcing

The term crowdsourcing, was coined by Jeff Howe (2006) in the computer magazine *Wired*. In his original article, crowdsourcing meant for him "[t]he new pool of cheap labour: everyday people using their spare [resources] to create content, solve problems, even do corporate R & D. "

Perhaps the most widely read reception of the crowdsourcing concept in the German language is that of Reichwald and Piller (2006), who place the phenomenon in an economics framework. They suggest the use of the term "*interaktive Wertschöpfung*" (interactive value creation) as a synonym for crowdsourcing. In fact, they define interactive value creation in exactly the same way that Howe now defines crowdsourcing. For both, it is "the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call" (Howe 2007; Piller/Reichwald/Ihl 2007: 87). Tasks outsourced in this manner can be tied to innovation (the creation of new knowledge) or to operational activities such as marketing or the con-

figuration of a product. In every case, however, the act of value creation is changed from a firm-dominated process to a process of co-production involving the active participation of customers and other internet users. This approach is virtually identical to Voß and Rieder's (2005) concept of the working consumer, which describes a new division of labour between firms and consumers such that consumers become active participants in the creation of value. Reichwald and Piller (2006) look to cost-benefit issues to better understand crowdsourcing and its recent rise; they stress that crowdsourcing is possible only when its costs are low and the requisite interaction brings benefits to all participants.

Reichwald and Piller (2006) differentiate between what they consider to be two forms of crowdsourcing: "mass customization" and "open innovation". Mass customization refers to the enhancement of operations so as to enable single purchasers to buy a product personalized for them alone. Open innovation, on the other hand, refers to cooperation between a firm and its customers in the development of a new product for the "benefit" of a larger circle of potential buyers.

At this point it becomes clear that the way, in which Reichwald and Piller define "interactive value creation", is too broad to be used synonymously for crowdsourcing because of their inclusion of the phenomena of mass customization. Mass customization refers to the isolated activity of individual customers as directed toward one unit of the product, not to the collective activity of many individuals as directed toward a general product type. Yet, central to the concept of crowdsourcing is the idea that a crowd of people, collaboratively (or at least simultaneously) contribute to an aspect of the production process or to the solution of a design issue or other problems. Their concept of "open innovation" – and it alone – corresponds to the meaning of crowdsourcing as understood here.

Another difficulty with Reichwald and Piller's (2006) definition is their assertion that individuals who respond to crowdsourcing calls must derive some kind of benefit from doing so. From a rational choice perspective, this conclusion is axiomatic. Since participation is voluntary, individuals participate only if they perceive that the benefits of doing so (however these may be defined subjectively) outweigh the costs. The problematic possibility that firms may be able to manipulate individuals' cost-benefit calculations falls outside of the paradigm. Yet, corporate consultants openly discuss crowdsourcing as a model in which participating consumers get absolutely no benefit from their participation. Examples include the use of corporate homepages to prompt customers to submit suggestions for improvement, new designs, and ideas. Customers who submit their ideas rarely receive adequate financial compensation for the work involved in doing so.

3.2 Technical Prerequisites for Crowdsourcing: Web 2.0

The term "Web 2.0" refers to internet applications that make possible new forms of interactive communication that go beyond conventional sender-receiver models. These types of applications are used for a wide variety of content and purposes including audio, reviews, bookmarks, communities, files, films, photos, graphics, instant messaging, jobs, personal contacting, art, music, news, podcasts, programming, travel, shopping, games, sports, search engines, tagging, texts, tools, video, weblogs, wiki, and knowledge. The high popularity of these applications among internet users indicates that they are tapping into a widespread yearning for active participation. The initial impetus for Web 2.0 programming came from the anti-commercial "open-source" movement, but the corporate world has since discovered it as a platform for its own goals.

"Web 2.0," a neologism that dates to 2004, does not signify a technological

or organizational advance in the infrastructure of the World Wide Web in its entirety. Rather, it refers to the increased prevalence of broadband connections coupled with the emergence of applications made possible by numerous software innovations such as content management systems and "dynamic" (as opposed to "static") HTML programming languages developed in the late 1990s. The term "Web 2.0" gives expression to the apparent fact that these technological innovations have spurred changes in the ways in which the World Wide Web is used and perceived (cf. Alby 2006: 1-19). Characteristically, Web 2.0 is about interactive and collaborative structures that enable users to create "user-generated content". In Web 2.0, users need not be mere recipients of media content but can actively take part in its production through activities like blogging, uploading photos and videos, etc. The essential technical prerequisite for these activities is "social software," or applications that enable communication, interaction, and collaboration through the internet (cf. Stegbauer/Jäckel 2008). The distinctive features of these applications include the enabling of user-generated content, the creation of elaborate platforms for interaction and networking, and user-friendliness. The central function of these applications is to get end-users involved collaboratively in the construction of an internet site and the generation of its content. In this way, individual knowledge becomes shared information. For a comprehensive overview of Web 2.0 see Alby (2006) and O'Reilly (2005).

In sum, the term "Web 2.0" serves to vaguely signify the fact that new options and forms of internet-use have changed and continue to change what the World Wide Web is, does, and means. Whether it will turn out to be just another marketing buzzword or a real revolution is another issue.

What is absolutely clear: Web 2.0 structures are being used commercially. Corporations are engaging in

forms of "open innovation" (cf. Hippel 2005; Chesbrough/Vanhaverbeke/West 2007; Drossou/Krempf/Poltermann 2006, Chesbrough 2006, 2007), in which they attempt to integrate internet users into specific internal production processes. Examples range from small Web 2.0 firms, whose entire capital consists of user-generated content, to the sporadic employment of Web 2.0 elements by established firms. Common to the many, heterogeneous examples of commercial Web 2.0 activity is that they represent attempts by a firm to animate internet users to contribute directly or indirectly to the process of value creation under its control. This is most starkly manifest in the phenomenon of crowdsourcing as defined here. Crowdsourcing is the clearest example of how firms can mobilize internet users to make a direct contribution to its processes of value creation.

3.3 Types of Crowdsourcing

Crowdsourcing applications are currently in a phase of experiment and innovation. Different types of crowdsourcing are in use, and it is currently difficult to predict which, if any, of these types will become dominant in the future. Start-ups based solely on crowdsourcing principles are often just trial balloons that later can turn out to be pure hype. However, the empirical phenomena of crowdsourcing can be organized typologically, as illustrated below.

Participation of consumers in product development and configuration

Calls by established firms for participation in the design or configuration of new products represent one of the most prevalent forms of crowdsourcing being used currently. These vary in intensity from simple opinion polls to elaborate schemes for the collaborative development of actual products by users. One example of product development in collaboration with consumers is the call announced by the auto manufacturer Fiat for its new Fiat 500. In just a few months, the call generated

ten million clicks, 170,000 designs from (potential) consumers, and 20,000 specific comments on things like particular exhaust pipe forms, chrome bumpers, or Italian flags under the rear view mirror. Additionally, consumers created a mascot and almost 1,000 accessories. The campaign was also a complete success from a marketing point of view. Of course, participating consumers were not compensated for their contributions. Their only wages were feeling their opinion mattered, the opportunity to apply their creativity, and the chance that their design ideas might be realized in the final design of the car.

and it is often initiated by young start-up companies whose business plans are based entirely on the crowdsourced product. Many of these start-ups are successful, in part because of the ready availability of good online tools for managing user input, and in part because a significant number of hard core internet users are aesthetes with an affinity for good design. Thus, it is not surprising that offerings like that of spreadshirt.net are well received. On this site, consumers can upload and manipulate text, graphics, and photos for creating individual t-shirt designs. Customers become designers this way and can then offer their final designs for sale in the Spreadshirt "market-

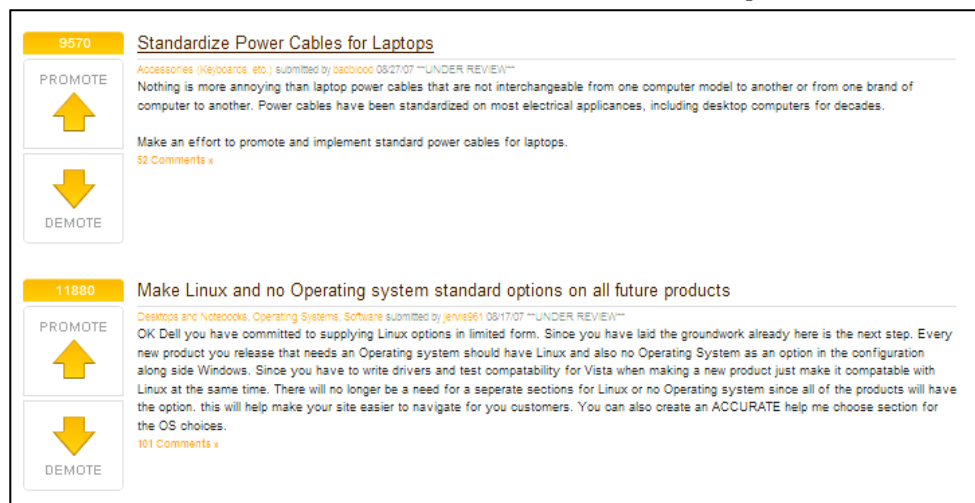


Chart 1 (Source: <http://www.dellideastorm.com>, last view: 03.01.2008)

A related example is Dell's "Idea Storm" (see Chart 1.). This is a call for comments and suggestions regarding the company's entire product palette, not just one single product.

Product design

Some crowdsourcing calls are intended to mobilize internet users for the creation of a product that wholly depends on their input. This kind of call goes well beyond the designing, configuring, and marketing of products that a firm already offers or could offer on its own,

place". Each designer is given their own on-line shop and can determine their prices within a given range. Spreadshirt handles t-shirt printing and delivery.

If a shirt is sold with a crowdsourced design, a portion of the proceeds goes to the designer. There are now thousands of t-shirt designs available and the company has been so successful that it was able to take over a French competitor, lafraise.com.

The example of Spreadshirt should be differentiated from a similar kind of internet platforming, discussed below as "market creation", that is only peripherally related to crowdsourcing as defined here. What Spreadshirt does is crowdsourcing rather than market creation, because it does not limit itself to matching t-shirt designers and buyers; it also sells its own designs and

their ideas. Their sole compensation is that their name appears on the final product.

Competitive bids on specifically defined tasks or problems

Another form of crowdsourcing that involves activating individual contributions from a large number of internet users is the public request for bids on


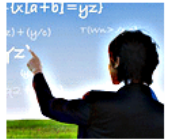

	<p>INNOCENTIVE 4470259 RTP 1047 project rooms open ALS Biomarker POSTED: NOV 06, 2006 DEADLINE: NOV 06, 2008 \$1,000,000 USD A biomarker for measuring disease progression in Amyotrophic Lateral Sclerosis (ALS or Lou Gehrig's Disease/ Motorneuron Disease) is needed. Read More</p>
	<p>INNOCENTIVE 5659803 Theoretical-IP Transfer 230 project rooms open Statistical modeling in clinical trials POSTED: NOV 30, 2007 DEADLINE: MAY 30, 2008 \$25,000 USD Improved statistical methods for post-study treatment adjustments are needed. More details are available once you register as an InnoCentive Solver. Read More</p>
<p>THE ROCKEFELLER FOUNDATION</p> 	<p>INNOCENTIVE 5644660 Theoretical-IP Transfer 257 project rooms open Solar-powered wireless routers POSTED: NOV 28, 2007 DEADLINE: JAN 28, 2008 \$20,000 USD A design for a solar-powered wireless router composed of low-cost, readily available hardware and software components is needed. The router is to become part of a reliable Internet communication network connecting metropolises and remote towns in developing countries. This challenge sponsored by the Rockefeller Foundation requires only a written proposal. Read More</p>

Chart 2 (Source: <http://www.innocentive.com/>, last view: 07.01.2008)

undertakes production and shipping of every shirt itself. Thus, Spreadshirt is really a t-shirt print-on-demand business that has outsourced a large share of product design to internet users via crowdsourcing but still does production and marketing in-house.

A similar example is the "open source footwear" platform of John Fluevog Boots and Shoes (<http://www.fluevog.com>).

On their site, consumers can create and submit ideas for new shoes. The company publishes the designs and organizes on-line voting whereby internet users select their favorites. The most popular designs are then manufactured and offered for sale. As the term "open source" suggests, however, successful designers are not paid for

specifically defined tasks or problems. Respondents are compensated financially upon completion of the task or resolution of the problem. A prominent example is Proctor & Gamble's *innocentive.com* (see Chart 2.), a platform intended to enable the company to tap into "expert knowledge" latently resident in the crowd.

Unsolved research questions are posted on <http://www.innocentive.com>, where they are read by thousands of people who can choose to try their hand at a solution. Over 100,000 potential "solvers" are already registered. Individuals who solve posted problems receive financial remuneration that varies with the difficulty of the problem and can be as high as \$100,000.

All those who work on a problem unsuccessfully receive no compensation.

Moviebakery¹, which uses this form of crowdsourcing also, is an internet-based agency that mobilizes amateur film directors and producers to accept commissions for internet advertising. Companies who want an ad turn to the site's owners, who post a call for submissions that fit the needs and wishes of the commissioning company. Persons can respond by sending in their videos. Moviebakery selects the ten "best" and pays at least €500 for each film. The commissioning company pays Moviebakery €10,000 and receives all ten videos plus distribution and promotion in the WWW by Moviebakery.

Permanent open calls

Another form of crowdsourcing that works on the principle of the financially remunerated bid request, but is not directed toward particular tasks or problems, is the permanent open call for the submission of information or documentation. The best known example of this practice is probably the use of "amateur reporters," who submit photos or short articles for publication or broadcast. CNN engages in this practice and allows its amateur reporters to send in material via cell phone.² CNN offers no compensation for voluntarily submitted material. In contrast, Germany's BILD newspaper offers its "reader-reporters" €500 for every nationally published and €100 for every regionally published photo.

Community reporting

Another way to transform informational inputs from a large number of internet users into a marketable product is to organize consumers into a "community" of registered users who report on new products, new trends or other kinds of news outsiders might be willing to pay for.

This is the strategy of trendwatching.com. It brings together over 8,000 "trend spotters" worldwide. These individuals are asked to notify the company regarding any observable changes in market supply or consumer demand; some even write reports or articles. This service complements traditional market research, which always has had difficulties getting timely information on the latest trends and market developments. For their contributions, trend spotters receive points that can be traded for incentives of modest value such as iPods or memory sticks. Trendwatching.com publishes a yearly trend report and sells current information to firms and customers who want to know what's "in".

Product rating by consumers and consumer profiling

Widely used in e-commerce is the practice of activating and publishing consumers' knowledge and opinions about products. Also common is the collection and utilization of data on the purchasing habits of its customers. The prototypical example for both activities is Amazon.com (<http://www.amazon.com>). One of Amazon's advantages lies in the fact that many customers submit unpaid reviews of products it sells. The information thus gained, however subjective it might be, is relevant for other customers as they make their own purchasing decisions. Amazon also entices its customers with additional information framed as "customers who bought the product you just bought also bought products X, Y, and Z". This information is generated through an analysis of the consumption profiles of all Amazon users.

Customer-to-customer support

Another kind of crowdsourcing practice is the organization of customer-to-customer support via chats and discussion forums. A distinction must be made between commercial and non-commercial forms. Non-commercial forms are discussed in the next section. Commercial sites are run by companies for the purpose of customer develop-

¹ See: <http://www.moviebakery.com>.

² See: <http://edition.cnn.com/exchange/ireports/toolkit/index.html>.

ment, allowing customers (or patients), to share their experiences with others facing similar challenges and problems. Experiences can be shared, users can challenge each other to competitions or grant emotional support. Companies thus enable and encourage a form of social support much like the traditional self-help group, but one that is closely aligned to the company and its products. On some health sites, for example, users can compare their physical fitness levels with others and thereby derive a competitive kick for their own exercise regimens. On Nike's platform,³ for example, users can upload their running times via their iPods and then use this data to engage in various competitions with other users.

Another example is the Coop-Online Coach⁴ in Switzerland, a site on which users trade information on healthy eating and exercise.

3.4 Phenomena Related to Crowdsourcing

There are many forms of interactive participation in production processes currently taking place in the internet that are similar to crowdsourcing but should not be conflated with it. Some of these are conducted by commercial firms, some by non-commercial project groups or forums.

Mass customization

Mass customization is an oxymoron composed of the terms "mass production" and "customization". It refers to a concept of production that attempts to capture the advantages of economies of scale while still taking each individual customer's preferences into account (cf. Pine 1993; Piller 2001; Piller/Stotko 2003; Hanisch 2006). The target is the mass market, but the product is designed in way that a small number of its features are variable and can thus be "personalized". Mass customization was made possible only by the advent

of modern computer and communications technology. With the help of an on-line software application, customers can configure their product by themselves. A prototypical example is the online-shop of the computer seller Dell. The company offers a few preconfigured computer models with components that can or must be altered in the course of the customer's ordering process. The result is that each customer creates her or his "own" computer. The company assumes implicitly that consumers have a command of the requisite knowledge about computer components and their functions. Mass customization involves the organization of a purchase such that specific design tasks are outsourced to the purchasing individual for a product that then becomes the property of that person. This differs from crowdsourcing, which is addressed to an unspecified quantity of consumers who do not become owners of the finished products.

Creation of limited access markets

One of the most important forms of user interaction on the internet takes place in the form of market transactions organized by a third party. The third party, whether it be a commercial or a non-profit enterprise, uses the internet to activate a latent market. Platforms that connect sellers and buyers, taking on a purely mediating roll but deriving financial remuneration for this activity, are related to the phenomena of interactive value creation and of consumer work. The product or service offered on the platform does not come from the company running the platform but derives rather from its users. This is crowdsourcing in the widest possible connotation since the success of the site's owner depends on how many individuals the company can animate to proffer their goods or services to potential sellers. Yet, this activity is not crowdsourcing by the definition offered in this paper because the organization of interaction by a third party (the company) represents the entirety of what the company does; the company produces nothing in the

³ See: <http://nikeplus.nike.com/nikeplus/>.

⁴ See: <https://www.coopcoach.ch/coop-diaet/>.

traditional sense and thus does not outsource mere parts of the production process. This is no longer co-production.

One form of market-creating activity is the creation of limited access markets. This occurs when firms secure the right to charge for entry. This often works much like real-space farmers' or flea markets: those who desire to sell their goods must pay market organizers for the right of access to a potential pool of buyers. In the internet economy, this is prototypically organized as a percentage commission on the value of goods and services actually sold. Examples include eBay, Amazon's "Marketplace" and Rent a Coder. Amazon's "Mechanical Turk" is one example where buyers, not sellers, pay for entry.

mission for their services. Only sellers and buyers are actually active on the site. The cost of the goods offered is determined either by the sellers alone or through the use of a time-delimited auction.

A newer but expanding field of limited access market creation involves online markets for tasks and jobs. This practice is similar to the form of crowdsourcing described above as "competitive bids on specifically defined tasks or problems" because an entity (usually a firm) addresses itself in the virtual marketplace via a bid request to a large group of individuals potentially interested in performing a specific task or job. But this practice should be differentiated from crowdsourcing, because the contracting parties do not

Find Folio Number View a HIT in this group			
Requester: Enovia Research	HIT Expiration Date: Jan 7, 2008 (4 days 12 hours)	Reward: \$0.04	
	Time Allotted: 60 minutes	HITS Available: 5	
Write a product review on a digital camera View a HIT in this group			
Requester: Junaid Ali	HIT Expiration Date: Jan 3, 2008 (6 hours 11 minutes)	Reward: \$0.20	
	Time Allotted: 60 minutes	HITS Available: 4	
Web Page Classification View a HIT in this group			
Requester: Steven Research	HIT Expiration Date: Jan 5, 2008 (2 days 3 hours)	Reward: \$0.10	
	Time Allotted: 60 minutes	HITS Available: 3	
Express Transcription: 1199295581.leon h fixed (avg rword+bns: \$1.34) [00:04 hh:mm] View a HIT in this group			
Requester: CastingWords	HIT Expiration Date: Jan 3, 2008 (3 hours 40 minutes)	Reward: \$0.67	
	Time Allotted: 4 hours 30 minutes	HITS Available: 3	
Write a product review on a camcorder View a HIT in this group			
Requester: Junaid Ali	HIT Expiration Date: Jan 3, 2008 (6 hours 11 minutes)	Reward: \$0.25	
	Time Allotted: 60 minutes	HITS Available: 2	

Chart 3 (Source: <http://www.mturk.com>, last view: 03.01.2008)

The internet auction house eBay (<http://www.ebay.com>) and Amazon.com⁵ run platforms that allow sellers and buyers to exchange information, enable different modes of payment, and establish a legal framework for the resulting transactions. The companies charge a fixed amount or a percentage of the transaction amount as a com-

interact directly with the company, although the hosting firm does skim off a commission. Users do business with each other, regulated by a conventional contract. Probably the most popular example of this kind of activity is the "Mechanical Turk" (see chart 3.) from Amazon.com, which was created to help firms outsource "HITS" ("Human Intelligence Tasks"). The concept underlying the "Mechanical Turk" is simple. It is assumed that humans can accomplish a wide variety of simple tasks (HITS), such as the identification

⁵ See: "Amazon Marketplace" at: <http://www.amazon.com/gp/seller/sell-your-stuff.html>.

of certain attributes of photographs, much better than computers. People who have too much free time can do the tasks and earn money in the proc-

fuels this Artificial Intelligence by coming to the web site, searching for and completing tasks, and receiving payment for their work."⁶

Job Title	Project Type	Category	Progress	Bidding Status	Time
ClipShare, vBulletin and Subdreamer Integration	Small Business Project: \$100(USD) and above	Web, MultiMedia	5 since Jan 3, 2008 6:57:12 AM	Bidding open Max bid: Open to fair suggestions	5 since Jan 3, 2008 6:57:12 AM
Web 2.0 Design of our current website redesign	Medium Business Project: \$500(USD) and above	Web, Page / Site Design, Graphics, Cascading Style Sheets (CSS), XML / XHTML, Prototype / Model	10 since Jan 3, 2008 6:56:59 AM	Bidding open Max bid: \$700.00 (USD)	10 since Jan 3, 2008 6:56:59 AM
flash animation	Very Small Business Project: under \$100(USD)	Graphic Design / Art / Music, MultiMedia, Artwork, Graphics	6 since Jan 3, 2008 6:56:38 AM	Bidding open Max bid: Open to fair suggestions	6 since Jan 3, 2008 6:56:38 AM

Chart 4 (Source: <http://www.rentacoder.com>, last view: 03.01.2008)

ess. The remuneration for each job is clearly indicated in the task description. A user can, for example, transcribe a four-minute interview for €0.83 or post articles on low traffic homepages for €0.02 per posting. In the case of Mechanical Turk, the buyer of services, not the seller, must pay for access to the market. These so called microjobs are carried out by individuals who get paid absolutely rock bottom rates. The sheer pleasure of activity of any kind, of being productive in any way seems to be a principle motivation driving individuals to accept the jobs. Yet, some observers have expressed reservations about this phenomenon, one reason being that Amazon's Mechanical Turk provides a means by which computers can be programmed to automatically integrate the work of humans directly into their processing. This gives Michael Arrington, founder of the weblog "TechCrunch" the creeps:

"I can't get the Matrix-we-are-all-plugged-into-a-machine vision out of my head. (...) To the [software] application [that has been programmed to use Mechanical Turk], the transaction looks very much like any remote procedure call – the application sends the request, and the service returns the results. In reality, a network of humans

Another example of limited market creation is Rent a Coder (see chart 4.), which has created a marketplace for software coders and buyers. Over 180,000 registered programmers respond to bid requests for coding projects posted by firms or individuals using the platform. Most of the 2000+ bid requests open at any one time look like this.

Creation of free access markets

Another form of market-creating activity involves the creation of free access markets. In these cases, companies activate markets but charge nothing for entry. Access to these markets is open and free of charge to "sellers" and "buyers". Sometimes market participants culminate their activity in an economic transaction, but more common is the exchange of goods and services – such as information or advice – free of charge. Site owners may be commercial enterprises but they get only derivative income from their sites, prototypically through advertising. Examples include flickr, YouTube, EzineArticles, and thousands of non-

⁶ See <http://www.techcrunch.com/2005/11/04/amazon-finally-shows-itself-as-the-matrix/>.

commercial information exchange platforms.

Internet platforms onto which users upload self-made content – such as films, videos, digital photos, animations, and presentations – represent perhaps the most popular type of free access market. The most widely used examples by far are the photo community flickr⁷ and the video community YouTube⁸. Each has numerous less successful competitors. On these sites, registered users can upload their photos or videos in unlimited quantity, virtually free from censoring. This content is catalogued in a searchable database, enabling millions of other users to find and link to them. Although users' activity on these sites is generally not commercially motivated, and neither members nor users are charged anything, these sites are owned and maintained by firms that are most certainly interested in making money. They do so through advertising, which is only possible because of the content generated by the participating community. Due to the enormous amount of content these sites offer, they are extremely frequently used, leading to significant advertising revenues. That YouTube was bought by the search engine company Google for \$1.65 billion in stock shows just how much such companies are worth on the current market.

An additional example is EzineArticles.com (<http://ezinearticles.com>). This company accepts articles from amateur authors, catalogues them in a searchable database, and offers them to publishers of online magazines free of charge. Neither authors nor editors pay for the service; it is a pure "matching service" that now has thousands of pages of current content for distribution.

The thousands of non-commercial information exchange platforms existing

today are further examples of free access market creation, although supply and demand revolve around information that is given for the asking. These include various forms of internet-chat platforms (with Web 2.0 these now encompass other formats such as wikis, blogs, and homepages) that enable the sharing of advice and other information on a wide variety of specialized topics. These are peer-to-peer information exchanges, all sustained by the ideal of a non-hierarchical internet community and the norms of open source and open content projects, as discussed below.

On a myriad of platforms, users solve problems for other users and thus work very much like a self-help group. Forums exist, for example, in which MS Word users describe their problems with the software and suggest or ask for problem solutions. On other forums, users relate their experiences with their cars; potential buyers of the same model can gather a wealth of first-hand information before buying. Members of vacation communities exchange tips on where to find the best beaches, members of cooking communities exchange recipes. On other platforms, users exchange information on home remedies for all kinds of ailments.

Open source and open content projects

Crowdsourcing is not the only work-like process by which users of the World Wide Web create products and services. Collaborative activities in the context of the open source and open content movement emerged earlier, and it may even be the case that these models inspired crowdsourcing. Open source projects like the operating system Linux and open content projects like the internet encyclopaedia Wikipedia had a decidedly anti-commercial impetus. When a user writes an article in Wikipedia, value creation in the economic sense does not occur because the product to which the user contributes is not exploited commercially. In contrast, when a firm

⁷ See: <http://www.flickr.com>.

⁸ See: <http://www.youtube.com>.

takes up an idea submitted by a user, that user makes a contribution to the firm's value creation process. Until now, the development of ideas always had been an internal task realized by regular employees.

In the context of open source and open content, peer-to-peer interaction is elemental. All participants are equal partners, and preventing the emergence of hierarchies is an important common goal. Since volunteers do all the necessary work with (usually) no corporation, and no paid employees behind the scenes, open source projects are not a form of crowdsourcing as defined here.

The products of open source and open content work are free for all to use. Individuals who work on a project are not compensated materially. Their only profit is recognition, reputation, or pleasure in doing things for others.

The bestknown example of open content work is probably the online encyclopaedia Wikipedia, which need not be discussed here. It is worth noting, however, that Wikipedia is considered to be the precursor and inspiration for open content projects in Web 2.0. A large number of more specialized but similar wiki-projects have been launched. A continually updated list of these can be found – where else but? – on a wiki platform.⁹

A related and interesting field of activity is open-content journalism. There are many "citizen journalism" or "grass roots" news homepages, the content of which is created independently by users. Examples like indymedia.org or zero.newsassignment.net show that the idea can work. However, unlike Wikipedia, the journalistic quality of these sites has yet to be evaluated. The owners and users of these sites consider themselves independent journalists working in opposition to mainstream reporting and adhere to open

source and open content conventions regarding democratic organization and freedom of speech. Other news platforms like thoof.com or newskick.de also work with user-generated content but employ a form of democratic editorial control pioneered by a website called digg (<http://digg.com/>). On these sites, users evaluate articles submitted by other users, and the site software to generate a ranking of most popular articles uses this information. Users can also subscribe to news feeds on topics related to their personal interest.

4 Factors Contributing to the Increasing Prevalence of Crowdsourcing

Crowdsourcing is part of a broad and historically significant trend, by which the capitalist firm is targeting consumers for integration into the process of value creation more than ever before, and in completely new ways, such as those now possible via the World Wide Web. Of interest from the perspective of the sociology and psychology of work is understanding why and how consumers are being systematically exploited as a "second type" of worker; i.e., as workers who receive no financial compensation or who are compensated at a level that is in gross disproportion to the value the company extracts from their input. This analysis can also be applied to areas beyond the internet economy.

Crowdsourcing represents the most explicit form of the integration of users (or consumers) in internal processes of value creation; it enables the direct utilization of consumer work for commercial purposes. The charging of commissions for the use of limited access markets represents another type of direct utilization that is possible within the context of the internet economy. Further instances of commercial utilization are indirect and include the use of Web 2.0 sites for advertising purposes or the cost-cutting transformation of customer

⁹ See: http://en.wikipedia.org/wiki/List_of_wikis.

service to customer self-service as in the case of internet banking.

Three important questions regarding crowdsourcing remain largely unanswered. What are the typical methods employed by crowdsourcing firms to mobilize and utilize the work of users and consumers? What motivates companies to crowdsource? What motivates users and consumers to respond and participate? The following theoretical reflections on these questions serve as a preliminary basis for future empirical study.

4.1 Firms Initiating Crowdsourcing

One of the most basic motivations for companies to establish an internet presence is the possibility of realizing cost reductions by expanding areas of self-service via the web. Costs are reduced when internal work processes can be transferred to the consumer ("outsourcing to the customer").

More important and more innovative are company activities meant to include users as active partners in the value creation process, making a direct contribution to company profits. This involves contributing to product innovation (the consumer as "co-designer"), contributing to product improvement (the user as "beta tester"), evaluating customer service (often the evaluation of individual service representatives or private sellers), or participating in the configuration of a product or its production.

Technological improvements (including not just the internet but new vending machines for all kinds of products and services) make it easy and inexpensive to integrate consumers into work processes. A company successful in doing so can reap a variety of benefits (Grün/Brunner 2002):

1. Cost reduction through reducing complexity. For example, the introduction of standardized internet portals reduces the complexity of interaction with consumers because portals restrict the variety of user transactions.

2. Productivity gains through more efficient use of resources. For example, companies can expand geographically and increase daily service hours without increasing expenses by using automated, self-service solutions.

3. Increase of turnover. Products can be offered at lower prices and more flexibly in terms of service hours and geographic distribution, resulting in an expansion of the customer base.

4. Quality improvement using consumer knowledge. In the context of integrating customers into productive processes, companies can make use of customers' expertise – in the use of company products, for example. In this way, customers can contribute to the betterment of product quality.

The first three advantages involve the outsourcing of work to customers using forms of self-service. The fourth kind of advantage arises through the integration of users as partners in the value creation process; it takes on other specific forms as well, such as the mobilization of consumers to develop product innovations.

Reichwald and Piller (2006: 149-154) name four additional benefits for firms arising from the mobilization of consumers in the value creation process. These are the reduction of the time it takes to develop new products ("time-to-market"), the reduction of the costs of innovation ("cost-to-market"), the increase of market acceptance of new products and consumers' willingness to buy them ("fit-to-market"), and the increase of consumers' subjective perception of the actual newness of a new product ("new-to-market").

Firms often closely emulate the aesthetics and rhetoric of the open source and open content culture in order to motivate users to participate in crowdsourcing projects. These campaigns orient themselves to images of self-determination, community orientation, and creativity. These correspond well to the areas in which crowdsourcing is most often employed: product configura-

ration and design, problem solution, and innovation. All these activities challenge individuals' creative capacities and are more likely to be subjectively satisfying to the participant. Yet, quite contrary to open source and open content culture is the practice, associated with some forms of crowdsourcing, of offering financial remuneration to those who produce the "right" or the "best" response to a bid request.

The orientation to open source and open content culture is probably strongest among crowdsourcing projects that target the internet's heavy users. Similarly, companies that sell purely crowdsourced products are likely to be oriented toward this culture strongly, especially if they were launched by private individuals who developed their business concept as a result of their experiences on the internet.

4.2 Respondents to Crowdsourcing Initiatives

The first and foremost question regarding individuals who respond to crowdsourcing initiatives is: Why do they do it? A theoretically oriented answer differentiates between extrinsic and intrinsic motivations. An extrinsically motivated person performs an activity in order to obtain some kind of external reward. Rewards for working consumers could be benefits for one's career, recognition for work done, or the satisfaction of pursuing common goals. An intrinsically motivated person, on the other hand, takes up an activity for its own sake – or for fun's sake (Ryan/Deci 2000).

It would be especially interesting to know which factors make activities worth doing for their own sake, making them intrinsically motivating. Some potential answers are offered by the theory of self-determination (Ryan/Deci 2000), according to which humans are drawn to activities that allow them to experience personal adeptness, autonomy, and social embeddedness. Thus, someone who is a talented skier can decide when and where to

ski, and can do it together with others. Her or he is intrinsically motivated and will ski even in the absence of external rewards. Following this pattern, Ryan and Deci (2000) identify clearly intrinsic and extrinsic motivations as well as mixed forms. Similar considerations on intrinsic motivation emerge from the job characteristics model (JCM) used in work psychology (Hackman/Oldham 1980). The model addresses itself to varieties of job tasks and identifies particular characteristics that would appear to increase the intrinsic motivation of workers. These are similar to characteristics that appear in other models of humane work such as worker autonomy and the ability to work in a holistic manner.

Among the studies of motivations underlying the special phenomenon of consumer work, a portion focuses on open source and open content projects. Another portion focuses on commercial enterprises.

Empirical studies of open source and open content projects strongly suggest that even when contributions are unpaid, extrinsic motivators are nevertheless often present. These include career related benefits (Robles et al. 2001) and the desire to acquire new knowledge, to share expertise with others, and to reach common goals (Gosh et al. 2002). Yet intrinsic motivation ("fun") appears to be the deciding reason for getting involved (Luthiger Stoll 2006). Inquiring into the origin of intrinsic motivations, a study by Lakhani and Wolf (2005) suggests that the experience of being creative is most closely linked to readiness to work on open source projects. In a very instructive study that used the Job Characteristics Model, Schroer and Hertel (2007) surveyed task characteristics associated with persons who work on the internet encyclopaedia Wikipedia. In their findings, readiness to participate was most closely associated with autonomy, task significance, and the newness of the challenge or "skill variety". Whether or not these task characteristics actually lead to participation

depended on the presence of intrinsic motivations. In other words, intrinsic motivations function as one mediator between task characteristics and participation. Contrary to expectations, strongly participating individuals reported an unfavourable personal cost-benefit balance. All indications are that participants are aware of the imbalance but possess an immanent willingness to participate anyway.

Keep in mind that participation in open source and open content projects serves community-set goals that are of great significance for collaborators. The situation is very different when working consumers collaborate with commercial enterprises. Why some consumers willingly do so was investigated by Bateson (1985), in an early study of a variety of different services. The study employed both qualitative and quantitative methods. The results indicated that consumers are willing to do more work themselves because they hope that by doing so they can save money and better control the service they receive (cf. Michel 1997, 2000; Voswinkel 2000). Reichwald and Piller (2006) found that besides the above mentioned intrinsic motivations, consumers who participate in forms of product innovation are also motivated by dissatisfaction with existing solutions and the expectation that they can help make products that are better attuned to consumer needs.

A number of additional studies focus specifically on self-service technologies (Dabholkar 1996; Meuter/Ostrom/Bittner 2000; Dabholkar/Bobitt/Lee 2003). Some studies investigated particular scenarios – for example, a fast food scenario in which interview subjects were asked to identify the conditions under which they would use self-service technology without any qualms (Dabholkar 1996). Other studies were based on field research involving self-service technologies already in use, self-scanning being one example (Dabholkar/Bobitt/Lee 2003). Based on their own and others' research Dabholkar, Bobitt, and Lee (2003) come to

the conclusion that the positive reception of self-service situations depends on the extent to which individuals anticipate being able to control the process. The expectation that using the technology would be fun also appeared to motivate customers. Other, less significant factors included time-savings, (low) required effort, (low) complexity, reliability, precision, and one's (positive) attitude toward technology. When asked about their preferences regarding interaction with employees, customers' opinions were split. Some considered it an advantage, others a disadvantage.

In sum, the primary motivations of working consumers are intrinsic ("for the fun of it"), but also of central importance are characteristics that make tasks fun (autonomy, creativity, importance of the task). Extrinsic motivations such as the satisfaction of pursuing common goals or timesavings are also relevant but appear to be less critical.

The studies reviewed above allow for an initial assessment of the motivations of working consumers, but a few caveats are in order. The studies commonly observe quite different motivations, making them difficult to compare. Many studies employ online questionnaires with one or, at most, a very few items for the factors being investigated. Affirmative answers on these items do not necessarily add up to a valid picture of the actual attitudes that permeate the projects. Comprehensive qualitative studies of the everyday behaviour of working consumers are needed to achieve this.

5 Conclusions

The essence of crowdsourcing, as defined here, is the intentional mobilization for commercial exploitation of creative ideas and other forms of work performed by consumers. Other Web 2.0 based activities that do not integrate users into a firm's value creation process are related but peripheral to

crowdsourcing. By responding to crowdsourcing calls, consumers contribute to a commercial firm's efforts at product and/or process innovation. Crowdsourcing represents, first of all, a quantitative expansion of the older trend toward integrating consumers in productive processes, in that it allows firms to reach a greater number of individuals. But it is also a good example of a new form of consumer integration, whereby persons who have no relations to the firm are persuaded to do work for it or its customers. Thus, crowdsourcing goes beyond classic co-production, by which consumers contribute to the production of a good or service that they personally consume. The phenomena of crowdsourcing confirm the working consumer thesis, detailed at the beginning of this paper: society is witnessing the emergence of a new type of consumer, whose work capacity is being increasingly exploited (usually with their full complicity) for commercial purposes. Whereas the emergence of the working consumer is independent of specific technologies, crowdsourcing has come into its own only with the advent of Web 2.0.

The future consequences of crowdsourcing for firms and consumers are a matter for conjecture. However, the following three aspects are likely to be among the most significant developments.

5.1 Distribution of profits and other economic consequences

For firms, outsourcing to the consumer carries a significant potential for increased profits, just as it puts regular employees at risk. Yet profits are not guaranteed. The ability of firms to realize economic benefits from crowdsourcing is conditioned upon many variables. Crowdsourcing strategies and platforms require significant investments; whether these investments pay off depends on how the crowd responds to the crowdsourcing call. Even the interaction with consumers itself

can be cost intensive, depending on the level of complexity involved.

Consumers also stand to benefit from participating in crowdsourcing. They may reap a (low) wage. In competitive situations, winners may be compensated quite well. In other cases, however, there is no remuneration.

5.2 Influence on product design

Some forms of crowdsourcing are used by firms to stimulate consumer cooperation in terms of product development and improvement. In the successful cases, firms profit from consumers' expertise and experience. Innovation provided by consumers can also be used for marketing purposes, as seen in the case of the Fiat 500 campaign. Yet when a firm enters the realm of internet communications, it exposes itself to new kinds of vulnerabilities. What happens, for example, to the firm and its image if customers and bloggers express disapproval of the company or its products?

Crowdsourcing gives consumers a new avenue of influence on corporate decision-making, at least indirectly through means such as recommending new designs and influencing public opinion. At the same time, consumers are themselves exposed to a new danger: the danger of being exploited by a corporation as a cheap supplier of valuable ideas stripped of control over their use. This dependency is somewhat alleviated when firms are at least willing to make public which consumer ideas were actually implemented. Dell engages in this practice on its "Ideastorm" platform.

5.3 Quality of work and working conditions

An important question for firms is whether the crowd actually can deliver quality work. Without question, the consumer is the real expert in the use of a firm's products and services, and their knowledge and experiences are of great potential value. Yet, several factors limit the quality of consumer work in practice. A central issue is the pro-

professional qualifications of participants involved in the productive process. Regular employees possess requisite qualifications as a condition of their employment. Questions and issues relating to the qualifications of working consumers are (as yet) unexplored and unresolved. This means that firms take a risk in transferring responsibilities to the crowd. For example, virtual health communities must decide whether they want to assume the responsibility for checking the soundness of medical advice posted by patients and possibly intervening to stem the spread of dangerous misinformation. Another problem is that consumers' expertise is very specific and relates only to the corporation's *front stage*, to use Goffman's (1959) expression. They know little or nothing about back stage processes, making them uninitiated in an essential area of knowledge, which company employees have at their disposal. This relative disadvantage could be lessened, of course, with future changes in the integration of working consumers.

An important issue from the perspective of consumers is the quality of the "working conditions" they face. Ideally, crowdsourced work or tasks will be organized to harmonize with their intrinsic motivations. Such work is characterized by high worker autonomy, opportunities for communication with others, the utilization of worker's special talents, and a linkage to personal development. Under these conditions – a best case scenario of crowdsourcing – respondents actually stand to gain a more satisfying work experience than in their real job.

There is no way to predict exactly what the working consumer of the future will be doing or how the relationship between consumer work and traditional employment will be organized. But the passive customer model is unlikely to dominate any longer. In response, future research in the field of labour studies likely will place a stronger emphasis on forms of work

that have little to do with "employment" in the traditional sense.

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Nanotechnology – An Empty Signifier *à venir*? A Delineation of a Techno-socio-economical Innovation Strategy

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received 19 December 2007, received in revised form 29 May 2008, accepted 23 June 2008

Abstract

The aim of this article is twofold: First, I would like to theoretically contribute to Science and Technology Studies, and to *Science, Technology and Innovation Studies*, respectively, by introducing a *hegemony- and discourse-theoretical inspired political economy* as an interdisciplinary approach. And second, I shall present some tentative empirical analyses of the policy field of nanotechnology.

Nanotechnology is widely perceived as *the* key technology of the 21st century. As a result, it is becoming increasingly important in many government policies devoted to technology. Nanotechnology is supposedly appealing for many actors, since it is expected to both produce entirely new materials and revolutionize production processes in virtually all industrial branches. Approaching the ‘nano-hype’ from a discourse-theoretical perspective, I shall show that nanotechnology is not a definite technology, but an *empty signifier*. This empty signifier provides the basis for an encompassing socio-economic project that is kept together only by the signifier itself. This “innovation project” creates a link between nanotechnology and the future of the industrialised states. It aims, above others, at their reconstruction along competitive criteria as ‘competition states’. Hence, I shall locate nanotechnology policies within a discursive field of political and economic interests and strategies.

My theoretical approach highlights the importance of hegemonic struggles for the construction of (political) reality. Hegemonic practices shape the discursive structure, which, in turn provides the strategic-selective conditions for articulation. Accordingly, policymaking can be described as a rather performative process, which uses complex systems of representation to establish a situation of stability and predictability. Hence, the governance of nanotechnology has to be understood as a contradictory battleground, where certain actors try to enforce their interests.

"Imagine a single area of scientific discovery with the potential to enable a wealth of innovative new technologies across a vast array of fields including healthcare, information technology, energy production and utilization, homeland security and national defence, biotechnology, food and agriculture, aerospace, manufacturing, and environmental improvement. Nanoscience (...) has this potential" (National Science and Technology Council et al. 2003).

"the world is about to be rebuilt (...) from the atom up. That means tens of trillions of dollars to be spent on everything (...) are all about to undergo profound and fundamental change. And as a result, so will the socio and economic structure of the world. Nanotechnology will shake up just about every business on the planet" (Josh Wolfe, quoted in ETC 2005a: 24).

1 Introduction

Nanotechnology is perceived as the "future technology" (e.g. Wood 2003), the "key technology" (c.f. Royal Society/ Royal Academy of Engineering 2004), and "the defining technology for the 21st century" (c.f. European Commission 2004a). The "nanotech-revolution" (c.f. ETC 2005b) is declared to have profound economic, ecological and social impacts on almost all societies, since it is expected to both produce entirely new materials and revolutionize production processes in virtually all industrial branches. As a result, this technology becomes increasingly important in many government technology policies. Since the Apollo moon programme, no scientific research endeavour has received more public funding than nanotechnology. Apparently, the "biotech century" – which according to Rifkin (1998: 1) entailed "a technology revolution unmatched in all history in its power to remake ourselves, our institutions, and our world" – has been surpassed by the "nanotech century" today.

A new and powerful technology emerges these days. But instead of taking this technological development as an inevitable and quasi-natural process, this article investigates the construction of the nanotechnology policy field and conceptualizes the governance of technologies as a contradictory ground of struggles. The aim is to disentangle the nanotechnology hype and

to locate nanotechnology policies within a discursive field of political and economic interests and strategies. Approaching the "nano-hype" from a hegemony- and discourse-theoretical perspective, the argumentation shall show that nanotechnology is not a definite technology, but an empty signifier and a political project that serves certain interests and strategies. It will be argued that nanotechnology acts as a kind of "carrier force" – as a technosocio-political innovation strategy – for economic expansion. In addition it serves for the reconstruction of the industrialised states along competitive criteria, especially in the advanced industrialised countries. However, technological development depends heavily on its public acceptance. Affected by the negative public perception of genetically modified food, governments pursue different strategies to gain approval for nanotechnology. This article focuses on articulations and narratives – stories that create meaning and orientation and form views – which constitute the policy field of nanotechnology and become hegemonic in regulation and governance of nanotechnology. One of the main analytical contributions to the current analyses of nanotechnology is to disentangle some strategies and interests important to understand nanotechnology. This should help to advance a socio-political analysis of nanotechnology, which in current studies is still underemphasised.

2 Nanotech inside?

Current analyses of nanotechnology within *Science and Technology Studies* (e.g. Glimell/ Fogelberg 2003a; Baird/ Schummer 2004, 2005; Baird/ Nordmann/ Schummer 2004a; Nordmann et al. 2006; Schummer/ Baird 2006) struggle with the very definition of the term itself. Obviously, the definition of nanotechnology is controversially debated (cf. Paschen 2003: 38; Decker/ Fiedeler/ Fleischer 2004: 10; Bundesamt für Sicherheit in der Informationstechnik 2007: 15). In fact, it has thus far proven impossible to even agree on the appropriateness of the term nanotechnology: “[A]s the term ‘nanotechnology’ encompasses such a wide range of tools, techniques and potential applications, we have found it more appropriate to refer to ‘nanotechnologies’” (Royal Society/ Royal Academy of Engineering 2004: 5), which is defined as follows: “*Nanotechnologies* are the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometre scale” (ibid.; italics in original). Accordingly, nanotechnologies have to be distinguished from “Nanosciences”, “[a]lthough there is no sharp distinction between them” (ibid.): “*Nanoscience* is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale” (ibid.; italics in original).

Most definitions of nanotechnology refer to the nanoscale, which (usually) varies between 1-100 nanometres (10^{-9} to 10^{-7} metre): “A broad (...) definition might be the area of science and technology that is currently evolving at the nano-scale” (Sweet/ Strohm 2006: 528-529). Glimell and Fogelberg (2003b) privilege such a definition as well: “*Nanotechnology is everything that occupies the scale of the nanometer. [...] A nanometer technology then naturally deals with the issue of how to control these molecules, atoms, and*

electrons, and about how this technology might be mass produced” (Glimell/ Fogelberg 2003b: 19-20; italics in original). But, even the scale is under debate: “The most liberal view of nanotechnology encompasses all technology that operates below the threshold of 1,000 nanometres, or one micron” (Feder 2004: 1). However, Schummer rejects this definition: “Since it applies ubiquitously, the nanometer scale is insufficient to define any particular or new kind of research” (Schummer 2004a: 16). The most restricted definitions are those, which refer to molecular manufacturing: According to this, nanotechnology is “the ability to understand, control, and manipulate matter at the level of individual atoms and molecules, as well as at the ‘supramolecular’ level, involving clusters of molecules. Its goal is to create materials, devices, and systems with essentially new properties and functions because of their small structure” (Roco 2004: 890).

Some researchers are surprised at these varying types of approaches to nanotechnology: “Given this tempest of activity, it seems unusual that a common and precise definition of “nanotechnology” is difficult to come by” (Sweet/ Strohm 2006: 528). Others claim the need for a commonly accepted definition: “In order to have meaningful discourse on the societal impact of nanotechnology, we must first agree on what we mean by nanotechnology” (Theis 2001: 60).

Hence, the question is why nanotechnology is that difficult to define. Some scholars think this difficulty arises from the fact that many researchers just use the label to apply for research grants (e.g. Stix 2001: 32; Glimell 2003: 71; Parr 2003: 6; Khushf 2004: 33-34). Others argue that it is the very “character” of nanotechnology as an “umbrella-“ or “enabling technology” (e.g. Fogelberg 2003: 42; Paschen 2003: 39). Moreover, for some scholars nanotechnology represents a culture-historical phenomenon (e.g. Baird/ Nordmann/ Schummer 2004b:

6; Schiemann 2006). In this article it will be argued that the above-mentioned reasons are not entirely mistaken, but they still do not capture the main issue, which is at stake.

The aim to analyse the discursive field of nanotechnology is based on the assumption that the definition of what nanotechnology entails is controversially debated. Historically, the physicist Richard Feynman is seen as the theoretical founder of nanotechnology. In his famous speech "There's plenty of room at the bottom" (Feynman 1959), Feynman developed the conceptual underpinnings of the possibility to examine, control, and manipulate matter at the scale of individual atoms and molecules without using the term nanotechnology. However, there are signs that Feynman was created retrospectively as the founder of nanotechnology (c.f. Toumey 2005; Nordmann 2007). The term "nanotechnology" was first used by Norio Taniguchi, referring to the capacity of precisely engineering materials on the nanometre scale (c.f. Taniguchi 1974). A breakthrough for nanotechnology was the research on the scanning tunnel microscope (STM) by Gerd Binnig and Heinrich Rohrer in 1981. While at the beginning it was only used to visualise molecular structures, scientists soon discovered that this instrument was also applicable to move molecules and atoms. In 1990, Don Eigler and Erhard Schweizer from IBM used a STM to move 35 xenon atoms (one at a time!) to write their company logo. But it was probably Eric Drexler, who popularised the term (c.f. Drexler 1986; Drexler/ Peterson/ Pergamit 1991; see below). Starting in the late 1980s, the term was used by more and more people, describing very different applications, processes, and fields of research. Interestingly, Drexler himself had a very narrow definition, defining nanotechnology as the "development of nanomachines able to build nanomachines and other products with atom-by-atom control (a process termed *molecular manufacturing*)" (Drexler 2004: 21; italics in

original). This narrow framing was broadened step by step to the point where it became completely blurred: "Apart from a characteristic size scale, it is difficult to find commonalities" (Royal Society/ Royal Academy of Engineering 2004: 5). I argue that the power of nanotechnology is partly due to its elusive character. Nanotechnology is not a definite technology, but an "empty signifier" (see below).

The term nanotechnology encompasses fields like nanomaterials, nanoelectronics and optoelectronics, bio-nanotechnology (incl. nanofood), nanomedicine, cosmetics and applications of information and communication technologies. Many applications and products labelled as *nano* are already available on the market. Others will probably be available in the near future (5-10 years) and some may never (or only in the far future) become reality. Only a few examples will be mentioned, in order to give an idea where the term nanotechnology is applied today. The first nanotech-labelled products appeared in the semiconductor industry to increase storage densities on microchips and in the pharmaceutical industry to improve drug targeting and diagnostic aids. The bulk of today's applications lies in the sphere of so-called nanoparticles (like "buckyballs" and "nanotubes"). Nanoparticles are said to be able to contribute to stronger, lighter, cleaner and "smarter" surfaces and systems. Therefore, nanotechnology is still not creating entirely new products but plays its part in the enhancement of already existing products. "Nanoparticles" are used in a wide range of "new" products: for example in the form of Titan dioxide and Zinc oxide to provide UV protection in sun creams; in the manufacture of scratchproof glasses; in lacquers and paints to provide better protection of surfaces against scratching, soiling or algae coverage; and in ceramic coatings for stronger solar cells.

Drawing on post-structuralist approaches, nanotechnology is conceptualised in this article as an empty signi-

fier.¹ An empty signifier is a signifier that has become detached from its previous particular content. Through (strategic) articulations this signifier tends to lose its particularity in order to become the name of fullness – a universality. Thus, an empty signifier is a hybrid of a particularity and a universality. This means, “that the signifier which is emptied in order to assume the representing function will always be constitutively inadequate” (Laclau 1996: 40). The empty signifier will always be a universality contaminated by a particularity, i.e. a *tendentially empty signifier* – an empty signifier *à venir* (cf. Laclau 2000: 304; Derrida 1999: 184).

The signifier nanotechnology denotes a universal technology that is able to solve the world’s most pressing problems: The provision of clean water worldwide, the satisfaction of global energy needs (with “clean” solutions), the maximisation of agricultural productivity, the creation of new jobs etc. Hence, nanotechnology can be seen as a techno-socio-economical innovation strategy – a strategy that offers a technological solution for socio-political problems. While Norio Taniguchi or, more probably, Eric Drexler coined the term, referring to the capability to precisely engineer materials on the nanometre scale, the term became more and more detached from that meaning – it became *tendentially empty*. By emptying the signifier from its “original” meaning it was possible to refill the term with different contents and associate it with other positive connotations, such as the “next industrial revolution”, (economic) wealth, sustainable development and knowledge-based society. Therefore, an empty signifier emerges in the hegemonic process of signification. At the same time, it retroactively acts upon the system it denotes, establishing a previously non-existent field. Societal forces struggle to launch such signifiers and to fill

their content hegemonically: “Society generates a whole vocabulary of empty signifiers whose temporary signifieds are the result of a political competition” (Laclau 1996: 35). And to “hegemonize something is exactly to carry out this filling function” (ibid: 44).

The empty signifier nanotechnology is intimately connected with the emerging narrative of the nanotechnology industry and the fantastic expectations surrounding the nanotechnology market. They all construct the narrative of a technology that will bring wealth to the people and could serve as a competitive advantage in the global struggle for market shares. In almost all advanced industrialised states, scientists and politicians emphasise the myriad of possible applications and marvelous benefits that will significantly change society. The advocates of nanotechnology “need” the broadness of the definition in order to construct a coherent narrative from very different sources. Up to a certain point, other technologies like biotechnology or genetic engineering could as well be described as empty signifiers, since they all invoke(d) a certain universality in bringing solutions to pressing societal problems. The salient and analytically interesting point in describing nanotechnology as an empty signifier is twofold: first, it is possible for different actors to use the term nanotechnology strategically for different purposes, since the term is very broad.² Second, it inaugurates a perspective in which nanotechnology is perceived as a political project. Thus, the governance of nanotechnology becomes a vibrant terrain, criss-crossed by hegemonic struggles. Hence, the analytical contribution at hand is first and foremost aiming at the deconstruction of some strategies and interests behind that “technology”. In addition it tries to advance a socio-political analysis of nanotechnology.

¹ Huber (2007: 5) brought forward a similar argument.

² I would argue the term is slightly broader than e.g. biotechnology.

To conclude this chapter, the guiding thesis is: nanotechnology is neither a definite technology or method, nor an array of applications or a research field. It rather has to be understood as an encompassing political project or, more precisely, as different political projects that are kept together only by the empty signifier itself. To designate nanotechnology as a political project does by no means suggest that no fundamental technological changes take place nor that this project will not have “real” and “tangible” implications for (wo)men and society. Nanotechnology, as an ensemble of different technologies *and* as a political project, is likely to have the potential to radically change the material livelihoods of many people (cf. Wullweber 2006: 106-112). Simultaneously, there is no *one coherent strategy* of a certain group guiding the nanotech project. Quite contrary, there are different interests and, to some extent, conflicting strategies competing. In order to be able to fully develop this argument, the theoretical tools guiding the research shall be delineated in the following.

3 Discourse, hegemony and political economy

The theoretical approach is committed to a discourse-theoretical ontology, which entails an understanding of systems of signification and subjectivity as importantly constitutive for social reality. Furthermore, the struggle for (political) hegemony is seen as a key feature of liberal and pluralistic democracies, and defines the very terrain in which a political relation is constituted. Finally, the approach draws on the heterodox economy. This is to integrate a middle-range theory, which is able to capture the importance of capital accumulation and modes of economic regulation for the analysis of capitalist societies in general, and for the analysis of nanotechnology policies in particular.

3.1 Discourse theory

Post-structuralist authors have emphasised the role of discourse as constitutive for politics.³ A discourse can be described as the sum of all verbal and non-verbal articulations on a particular topic, shaping the perception, thinking, and action of individuals. Within this conception of discourse, language, action and meaning are closely connected: “Meaning is learned from, and shaped in, instances of use; (...) so meaning is very much the product of pragmatics” (Pitkin 1972: 84). Articulation is understood as a “practice establishing relations among elements such that their identity is modified as a result of the articulatory practice” (Laclau/ Mouffe 1985: 105). Thus, a discourse is a structure – more precisely an entity – which has a significance in a social, economic, or political context. It can be seen as a relational ensemble of signifying sequences, which together constitute a more or less coherent framework of what can be said or done. But discourses are not simply reflections of these contexts. They rather are complex mediations between various codes, which assign possible meaning to reality (c.f. Gottweis 1998: 31-34). Furthermore, a discourse fails to invoke a complete closure, since there is always something escaping the infinite processes of signification – an irreducible “surplus of meaning” (Laclau/ Mouffe 1985: 111).

Post-structuralist approaches highlight the importance of discourse for the construction of (political) reality. They highlight the constructed nature of actors in politics and society, and the phenomenon of competing, conflicting, and often contradictory structures of meaning and expression in social and political life. The pre-discursive meaning of entities such as institutions, subjects of policymaking, and political identities is denied. This is due to the reasoning that the notion of a “reality”

³ Sometimes also called “postconstructivism” (cf. Wehling 2006).

with a fixed and pre-discursive meaning fails to recognise the analytical difference between “being” (lat. *esse*) and “existence” (lat. *ens*). The (physical) “existence” of objects is not dependent on their discursive articulation, i.e. existence extraneous to any meaning. But the “being” of objects (their meaning) depends on their articulation within discourses. Accordingly, there is no *meaningful* “reality” outside the field of discursivity. But the “discursive character of an object does not, by any means, imply putting its existence into question” (Laclau/ Mouffe 1990: 82, cf. 103).

The “truth” of an event will always be the contingent outcome of struggles among competing discourses and narratives, transforming “what is out there” into a socially and politically relevant concept. The outcome of these struggles is contingent, insofar as no actor can anticipate the exact results of his or her action. However, the “scope of possibilities” to determine a discourse differs much among the actors. Strategic articulations are an important part of discourses and can be understood as an attempt to establish a chain of equivalence between different discursive elements. According to Gottweis (c.f. 1998: 31-34), successful articulations bring elements of stability and order into what is part of the available repertoire of political visions and identifications in one's social situation. They are modes to organise political, scientific, and economic reality. Therefore, an articulation is a material and strategic practice that “inscribes itself into the texture of the social and creates or rewrites order by drawing from a manifold of discursively available narratives and modes of representations” (ibid.: 333). But, it is vital to stress the fact that “structures rarely have a simple, unequivocal relation to a single strategy” (Jessop/ Sum 2006: 66). By introducing the neologism “discourse-organisation”, the argumentation intends to characterise a relatively stabilised spatio-temporal, socio-political and strategic-selective

structure of a specific society, including general concepts and values of social order. Fordism or neo-liberalism, for example, can be described as forms of discourse-organisation. A discourse-organisation is a stabilised set of discourses, where meaning does not float freely anymore but is fixed to a great extent. Thus, the horizon of possibilities is limited.

A post-structuralist theorising of nanotechnology puts emphasis on power struggles and interests, and also takes into account contingent-accidental events as constitutive for technological development. It criticises the notion that technological development is an inevitable and automatic progress of science as well as the assumed progressive character of scientific development. In post-structuralist rendering neither the “truth” of nanotechnology as the technology of the 21st century nor the policy problem “nanotechnological risks” or the “high-technology gap” are simply existent. Rather, the question is what constitutes a “high-technology”, whose interest does this kind of framing serve, and what social forces try to articulate such tropes. Thus, science and power are conceptualised as two strongly interconnected phenomena, and the a priori existence of stable boundaries between economy, politics and science is questioned.

3.2 Hegemony

The question is, whether certain articulations within the nanotechnology discourse are able to become hegemonic. Hegemonic in the sense that nanotechnology becomes widely accepted as a technology producing wealth for the society. The conception of hegemony used in this article derives from Gramsci's approach. For Gramsci hegemony means the ability of the ruling groups to pursue their interests in such ways, that the “ruled” groups regard these interests as common or general interests. Hegemony is perceived as an active consent of the ruled (c.f. Gramsci 1971: 180-182). (Neo-)Gramscian ap-

proaches introduce a concept of power that primarily rests on the ability to universalise the particular interests of a group as a socio-economic and political structure. A certain group is hegemonic, and not only dominant, if it succeeds to win approval of its authority among members of other societal groups. The “ruling groups” have to be responsive, at least to a certain degree, to the respective interests of other groups. Identity of interests can be achieved by taking into account the interests of other groups in the formative processes of institutionalization. These interests have to be merged, so that they become equated with the very institutions (c.f. Cox 1996: 99-100).

From a post-structuralist point of view, the concepts of discourse and hegemony are inextricably linked and mutually conditioned. Hegemonic practice shapes discourse, which in turn provides the conditions of possibility for hegemonic articulation (c.f. Mouffe 1979: 179). Framed like this, hegemony is a type of social relation. It can be described as the widening of a particular discourse – in the form of a socio-political project – towards a certain horizon of social orientation and action, i.e. a discourse-organisation, through the articulation of unfixed elements into partially fixed moments. The ambit and the horizon of a particular discourse-organisation are constituted by the exclusion of competing discursive elements (“social antagonisms”). The exclusion of alternative articulations into a discursive “exteriority” is the substantial element of hegemonic practices of articulation. The organisation of a hegemonic discourse depends on its coherence to provide a surface of inscriptions for a wide range of wants, meanings, interests, and beliefs. “The fact, that one discursive formation gains influence over another, that it becomes *hegemonic*, is related to the degree of congruence and complementarity that this discursive formation has within a given discursive constellation” (Gottweis 1998: 36; italics in original).

To be successful, i.e. to become hegemonic, a socio-political project has to be articulated in relation to the (imaginary) common good. Since the common good only exists as an imaginary common good, and hence as an empty place, there are only particular interests, which try to occupy this empty space through strategic articulations (cf. Jessop 2007: 11). Thus, a hegemonic project has to be articulated in a specific way: In these processes of articulation a multiplicity of subjects, actors, and relevant forces do not only act on the assumption that the implementation of the project is a prerequisite to achieve the common good, but adopt precise positions, which are provided through the hegemonic project. Three general requirements have to be achieved in this regard: First, there is the need for an empty signifier, since every socio-political project requires a signifier, as a medium of representation. And, as stated above, an empty signifier “unifies a given field, constitutes its identity: it is, so to speak, the word to which ‘things’ themselves refer to recognize themselves in their unity” (Žižek 1989: 95-96). Secondly, the empty signifier has to have a positive connotation within the discourse in question. It has to hold a privileged relation vis-à-vis the common good. At the same time, alternatives to the hegemonic project have to be presented as unimaginable and unrealizable. And thirdly, the discourse promoted by the hegemonic project has to be relevant for society. Hence, the analysis of the hegemonic discourse-organisation and the analysis of the overall socio-political context is essential for the evaluation of a hegemonic project.

3.3 The “competition state”

Many studies have explored the alterations of the state in the era of globalisation. Almost all analyses share the notion that the form and structure of the state changed since the 1970s (e.g. Lipietz 1987; Wood 1997; Jessop 2007). In this context, the notion of the internationalisation of the state

refers to different and often contradictory policy answers within the state apparatuses to handle this new situation. It will be argued, that the hegemonic discourse to reconstruct the state in the advanced industrialised countries is one, that emphasises a state that has to become streamlined along competitive criteria; and that nanotechnology plays an important role in supporting this discourse.

Jessop (c.f. 1990) emphasises that the state is not a pre-given structure but a precarious social relation whose unity has to be actively constructed and maintained permanently. Furthermore, the state is characterised by strategic selectivity, insofar as “the state is not equally accessible to all social forces, cannot be controlled or resisted to the same extent by all strategies, and is not equally available for all purposes” (Jessop 1990: 317). The state can be seen as a battleground – a matrix – for struggles over political hegemony in terms of competing definitions of the common interest. Within this process of permanent reconstruction, technological policies, trade policies, and social policies are all mutually reinforcing discursive practices: “The articulation of (...) discursive-strategic shifts into new accumulation strategies, state projects and hegemonic projects, and their capacity to mobilize support are shaping the restructuring and reorientation of the contemporary state and helping to produce new regulatory regimes” (Jessop 2002: 133). However, the attempt to organise actors, articulations, and meanings is usually only temporarily successful.

The guiding argument is, that the rise of nanotechnology is strongly connected to the development of certain tendencies that streamline state policies along allegedly competitive factors. The congealed form of these paradigms of competitiveness will be described as the discourse-organisation of a “competition state”. A competition state can be identified as a discourse-organisation, insofar as it consists of a variety of different discourses

that have been articulated in and through hegemonic practices. International competition has become important. Today, states are placed on the sliding scale of a global competitive indicator on the basis of their assumed competitiveness (ibid.: 119-120).

The discourse-organisation of the competition state frames a state aiming to secure economic growth within its borders, while ensuring competitive advantages for capital on its territory. This can be achieved by promoting the economic and extra-economic conditions that are perceived vital for success. It emphasises strategies to create, restructure or reinforce the competitive advantages of its territory, population, social institutions and economic agents. This discourse-organisation highlights certain characteristics that can be depicted as “Schumpeterian”, “because of its concern with technological change, innovation and enterprise and its attempt to develop techniques of government and governance to these ends” (ibid.: 96). For Joseph Schumpeter, entrepreneurial innovation can proceed in different ways (cf. Lim 1990): via the introduction of a new good or a new quality of a good, via the introduction of a new method of production, via the opening of a new market, via the conquest of a new source of supply of raw materials or half-manufactured goods, and via the implementation of the new organisation of any industry. This approach highlights a prevailing thought of how society should be restructured in the light of a paradigm of innovation and competition. As it will be argued below, this narrative creates a link between nanotechnology and the industrial future of the advanced industrialised states. The notion of the competition state also has to be applied to competitive regions like the European Union.

4 Nanotech – a techno-socio-economical innovation strategy

The actual “nano-hype” plays an important role for the political contextualisation of nanotechnology in general, and for the present analysis in particular. “[F]or now the products seem relatively modest compared to the preceding hype” (Arnall 2003: 2). As the U.S. National Initiative (2003) states, “nanotechnology has the potential to profoundly change our economy, to improve our standard of living, and to bring about the next industrial revolution.” It is suggested that nanotechnology is at approximately the same stage of development today as information technology was in the early 1960s, or biotechnology was at the beginning of the 1980s (c.f. Department of Trade and Industry 2002).

Both scientists and politicians promise revolutionary breakthroughs generated by nanotechnology: new ways of detection and treatment of diseases, in drug development, in the monitoring and protection of the environment (e.g. water decontamination), in the production and storage of energy, or in enhanced information and communication technologies. In their view, nanotechnology will enable to build complex structures as small as an electronic circuit or as large as an aeroplane, and produce stronger and lighter material (c.f. Royal Society/ Royal Academy of Engineering 2004: 1; Department of Trade and Industry 2002). Nanotechnology is perceived as an instrument to make powerful information technology available everywhere, to maximise productivity in agriculture, to increase health and longevity of human life, to provide abundant clean water globally, and to meet global energy needs with clean solutions.⁴

To understand the nanotechnology hype, one also has to take into account the most utopian expectations for future applications of nanotechnology. According to these visions, the most promising applications will stem from processes called “self-assembly” or “molecular manufacturing”. Self-assembly refers to the tendency that some materials are spontaneously “able” to arrange themselves into ordered structures (c.f. Antón/ Silberglitt/ Schneider 2001). The goal and aspiration is to build desired structures from atomic scratch. The idea is not only to manufacture individual particles with useful properties, but to manufacture complex and useful structures made from multiple molecules. Hence, the desired outcome of nanotechnology is the manipulation and assembly of nanoscale particles into supramolecular constructions and even larger structures. Some scientists (most notably the controversial person of Eric Drexler) believe that one day molecular manufacturing will be possible, i.e. to control atomic positioning so precisely that any object whose atomic composition is known could be assembled from its basic units (Drexler 1986, 2001).

4.1 The nanotechnology market

In the following, it will be argued that the nanotechnology discourse is supported by different strategies, specified as the narrative of the nanotechnology market, the narrative of the knowledge-based economy, and the narrative of the nanotech-race. Economic interest in nanotechnology is not automatically given. Rather the interest itself is socially constructed and serves certain strategies. After years of basic research it is still uncertain if nanotechnology will produce substantial goods for the market. Nevertheless, there are countless studies that assess the possible impact of nanotechnology for future markets. Some sources state that by 2012 the entire market will be dependent on nanotech (c.f. Arnall 2003: 22). Although there are still only a few nanotechnology products on the mar-

⁴ See for example Foresight Nanotechnology Challenges (URL: <http://www.foresight.org/challenges/index.html>; last view 8 May 2008).

ket, growth is expected to be strong, with a composite annual growth rate of 30–40% (c.f. Department of Trade and Industry 2002). The market confidence in nanotechnology is reflected by a number of forecasts. Miles and Jarvis (c.f. 2001) assess the market for nanotechnology-based IT and electronic devices at around US\$70 billion by 2010. Roco and Bainbridge (c.f. 2001: 11) argue that nanotechnology will bear an annual production of about US\$300 billion for the semiconductor industry, and about the same amount for global integrated circuits sales within 10–15 years. For micro- and nanotechnology systems in the telecommunications sector, the market is presently estimated around an amount of US\$35 billion with an anticipated compound annual growth rate of around 70% (c.f. Arnall 2003: 22). The U.S. National Science Foundation (NSF) has predicted that the market for nanotechnology products will exceed US\$1 trillion by 2015 (c.f. Royal Society/ Royal Academy of Engineering 2004: 1). In 2004, the NSF revised its forecast, estimating that the US\$1 trillion market would come and go in 2011 (c.f. ETC 2005b: 6).

These immense expectations create an image of future markets, which is only achievable if the industry branches move up the technological ladder and align their R&D policies with the nano-scale. For this reason all advanced industrialised countries, almost all Fortune 500 companies and two-thirds of the companies in the Dow Jones Industrial Average, convey nanotech research, development, and investment in some way. The technological competence in nanotechnology is allegedly a compulsory condition to compete successfully with better procedures and products on future markets. At the same time, a view becomes hegemonic that does not permit any alternative to the development of nanotechnology, since the nations which fall behind will miss the junction to the future markets. Hence, nanotechnology becomes a synonym for innovation within the

competition states. As nano-materials and -processes apply to many manufactured goods, in almost all industry sectors, control and ownership of nanotechnology is decisive for virtually all governments and for the competitiveness of industry: In terms of attracting initial investment, and to ensure future revenue. With certain patents it will be possible to control complete chains of production: “Don’t bet the jockey. Don’t bet the horse. Own the track” (Lux Research 2004: 186). Apparently, nanotechnology is the first research field in which the basic ideas and applications are patented from the outset: the most basic ideas and fundamental building blocks in nanotechnology “are either already patented or may well end up being patented” (ETC 2005b: 10). Hence, intellectual property rights are a key element in both, the knowledge-based economy and the global competitive struggle for (global) market shares, since “companies that hold pioneering patents could potentially put up tolls on entire industries” (Regalado 2004: 1). The “race” for the nanotechnology patent “gold rush” (ETC 2003: 24) has started among TNCs, leading academic labs, start-ups and universities.

4.2 The narrative of the knowledge-based economy

One feature of capitalist developments is the permanent process of primitive accumulation: the transformation of formerly “common good” into private property, the separation of producer and means of production, and the creation and enforcement of capitalist relations of production (c.f. Marx 2001: 741–791). The material (and often violent) process of primitive accumulation is mediated and backed up by an array of discourses. Within the competition state, the process of primitive accumulation refers more systematically and accentuated than before to knowledge and its commodification and privatisation (for the relation between primitive accumulation, genetic resources and traditional knowledge see Wullweber 2004). Apparently, the factor “knowl-

edge" is getting more important for international competitiveness: "To create wealth and new employment in a globalised market and within a knowledge-based economy, the competitive production of new knowledge is essential" (European Commission 2004b: 9). Jessop (c.f. 2002: 96) describes the contemporary era, generally as a knowledge-based economy (KBE). The notion of the KBE can be conceived as a narrative within the discourse-organisation of the competition state supporting and articulating today's process of primitive accumulation. The KBE is the widely taken-for-granted focal point of accumulation strategies, state projects, and hegemonic visions. It is a nodal point, a privileged discursive point that partially fixes meaning within signifying chains (c.f. Laclau/Mouffe 1985: 112).

The nanotechnology discourse concurs with the issue of knowledge generation and the narrative of the knowledge-based economy in policy speeches, documents, and programmes. Philippe Busquin, European Commissioner for Research, states that "nanotechnology provides a golden opportunity for the creation of new knowledge-based enterprises and has a 'revolutionary' potential that can open up new production routes" (European Commission 2004b: 1). Likewise, the EU Commission declares on its research homepage: "Nanosciences and nanotechnologies are crucial to the establishment of a knowledge-based EU society and economy" (European Commission 2004c). According to this logic, "Europe must (...) transform its world-class R&D in N&N [Nanosciences and Nanotechnologies] into useful wealth-generating products in line with the actions for growth and jobs" (Commission of the European Communities 2005: 2). Together these narratives frame nanotechnology as a competitive advantage for the industrialised countries.

4.3 International competition and the "nanotech-race"

Nanotechnology is framed discursively as a technology that is *the* pre-eminent factor for achieving a nation's innovation: It does not only introduce new goods but also offers a new quality of goods, it ushers new methods of production, it opens up new markets. And finally, it offers a new source of supply of raw materials. Nanotechnology is preordained as the magic tool leading to the production of ever smaller, faster and more efficient products with acceptable price-to-performance ratio. This has become an increasingly important success factor for many industrial branches in international competition.

Thus, the empty signifier nanotechnology serves as a techno-socio-economical innovation strategy. The U.S. National Science and Technology Council states (2003: 3): "Because nanotechnology is of such critical importance to U.S. competitiveness, both economically and technologically, even at this early stage of development, it is a top priority within the Administration's R&D agenda". In a similar way, the European Commission argues: "Advances across a wide range of sectors are being enabled through R&D and innovation in N&N [Nanotechnology&Nanoscience]. These advances can address the needs of citizens and contribute to the Union's competitiveness and sustainable development objectives and many of its policies including public health, employment and occupational safety and health, information society, energy, transport, security and space" (Commission of the European Communities 2005: 2).

The ascription to nanotechnology of being an innovation, and hence a competitive advantage, gives rise to an enormous global nanotechnology race among the industrialised nations. Apparently, the race is on to win monopoly control over the expected huge nanotechnology market and to win a share of the 2 mio. nanotechnology

workers, which are said to be required by the nanotechnology industry (c.f. Roco 2003). Between 1997 and 2006, government's investment in nanotech R&D increased from 432 million US\$ to about 4681 million US\$ a year (c.f. Roco 2007: 30). In 2007, industry and governments invested an estimated 13,9 billion US\$ in nanotech R&D worldwide. In 2009, the U.S. funding for nanotechnology will grow to a sum of 1527 million (cf. National Nanotechnology Advisory Panel 2008: 9). The "nanotech-race" is now at centre stage of many government science and technology policies.

States play a crucial role in promoting innovative capacities, technical competence, and technology transfer. They hope that as many corporations and economic sectors as possible may benefit from the assumed new technological opportunities created by nanotechnology R&D activities. Within this competitive climate, the "systematic generation of science and technology (...) becomes an important area of the functions of the state administration" (Hirsch 1978: 94). The nanotechnology discourse, combined with the narratives of the nanotech-race and of a knowledge-based economy, supports the (re-)construction of the competition state. The competition state has to "focus upon (...) knowledge-based industrial innovation ('nanomanufacturing'), integration at the macro-micro-nano interface and interdisciplinary ('converging') R&D. Appropriate synergy with the European Strategy on Life Sciences and Biotechnology may also be beneficial" (European Commission 2004b: 8).

However, a nanotech-race is not simply existent. Rather, the creation of the narrative of a nanotech-race is the outcome of constitutive practices and hegemonic struggles. The actors within the nanotech-race are not acting independently from the different discourses, which in many ways have an influence on how these actors view the world, define their goals, and structure their actions. The perception of "a

highly competitive global economy" (Her Majesty's Government 2005: 1), and the prevailing analysis that only those nations thrive "that can compete on high technology and intellectual strength" (ibid.), supports the narrative of the nanotech-race to become hegemonic.

5 Public acceptance – nanotechnology without antagonism?

As stated above, the success of a hegemonic project depends heavily on its public acceptance. Thus, the "public trust and acceptance of nanotechnology will be crucial for its long-term development" (European Commission 2004b: 19). Advocates of nanotechnology have to win the "perception wars" (Mitsch/ Mitchell 1999) to become hegemonic. In the field of GM-food, governments have already experienced that the governance of high technology is difficult. In the 1990s, GM-foods were value-detracted instead of value-added and the "perception wars are being lost by industry, one battle after another" (ibid.). Governments apparently try to pursue new strategies to avoid "another backlash like the one over genetically modified foods" (Boyd 2003) for nanotechnology. In my ongoing empirical research (cf. Wullweber forthcoming), I have identified several hegemonic stratagems⁵: a) articulation of the empty signifier; b) super-differential border-drawing; c) articulation of equivalence of different demands; d) legitimate difference; e) antagonistic division of the discourse; and f) expansion of the chain of equivalence. So far, the different strategies seem to be successful, since the resistance to nanotechnology is by no means as strong as e.g. the anti-GMO protests. In the following, the strata-

⁵ The term "stratagem" denotes a generic term for different strategies that show "family resemblance" (Wittgenstein; cf. Nonhoff 2006: 207-240).

gem of “legitimate difference” will be shortly discussed.

Generally, the stratagem of “legitimate difference” aims to integrate potentially antagonistic positions into the hegemonic chain of equivalence. Potentially antagonistic demands become simple contradictions – legitimate differences – within the hegemonic project. These strategies strengthen the hegemonic project, because it can be indicated that critical actors are not only heard, but that they are part of the project in question. Their potential to mobilise critical societal forces is bound. Furthermore, a broader audience is addressed. The unit “Nano- and Converging Sciences and Technologies” of the EU-Commission declared: “It could be useful to involve powerful NGOs (for example Greenpeace) to attract a broader audience to dialogue” (Bonazzi 2007: 26). However, it is not about a one-sided integration: By involving certain positions and actors, the hegemonic project itself will be transformed to a certain degree.

The majority of people in the advanced industrialised states do not as yet have much knowledge about nanotechnology (for Europe cf. Eurobarometer 2006; Bundesinstitut für Risikobewertung 2007; for the USA cf. Priest 2006: 565; Kahan 2007). This poses a problem for protagonists of nanotechnology, because “[w]ithout a serious communication effort, nanotechnology innovations could face an unjust negative public reception” (European Commission 2004b: 19). With regard to genetic engineering “the lack of sufficient public scientific data on GMOs, whether positive or negative, was a controlling factor in the industry’s fall from favour. The failure of the industry to produce and share information with public stakeholders left it ill-equipped to respond to GMO detractors” (Colvin 2003). Thus, advocates of nanotechnology start public debates, because “an open public dialogue with citizens and consumers is absolutely necessary as a basis for an objective judgement

on nanotechnology and to avoid baseless fears” (Luther 2004: 94).

Many “nano-dialogues” are launched in countries, which run nanotechnology programmes. In 2005, a European Commission-funded project “Nanologue” was launched to address a Europe-wide dialogue on benefits, risks and social, ethical and legal implications of nanotechnology (cf. Nanologue 2005). In 2006, the European Communication Project “Nanodialogue - Enhancing dialogue on Nanotechnologies and Nanosciences in society at the European level” was inaugurated (cf. www.nanodialogue.org). A communication tool called “Decide – Deliberative Citizens Debate” has since been developed (cf. <http://www.playdecide.org/>). Furthermore, different citizen panels were organised: the so-called “NanoJury UK” in Great Britain (cf. Greenpeace 2005), a “consumer conference” in Germany (cf. Bundesinstitut für Risikobewertung 2006), the “Citizen Consensus Conference on Nanotechnology” in Wisconsin/USA (cf. Kleinman 2005) and others, for example in France, Denmark, the Netherlands and Finland. However, these dialogues are obviously restricted. They are “open” as long as they address “baseless” fears and construct an “objective”, and, hence, positive judgement of nanotechnology. Critical recommendations are usually ignored, because they shall not slow down the process of technological development, but rather “reduce misunderstanding and obstruction” (Boyd 2003). Apparently, the overall goal of all these programmes is not to discuss possible problems but to achieve acceptance for nanotechnological development.⁶ Not the risk of nanotechnol-

⁶ In contrast, Schummer (2004b: 56) provides a more positive analysis of the current nano-dialogue: “That appears to be a great opportunity for cultural and social scientists to engage in partnership models with scientists and engineers such that both groups can immensely benefit from each other, for the overall benefit of the society.”

ogy is at stake but its “smooth” development. Hans Kastenholz of the Swiss Federal Laboratories of Material Testing and Research, which is part of the Nanologue, states: “Consumer acceptance will be key for nanotechnology’s future development and thus key for financial markets and venture capitalists. [...] Engaging society in a dialogue about the opportunities and potential risks will address and help to mitigate some of these uncertainties surrounding the issue” (Nanologue 2005). Nevertheless, this stratagem already produces lacks in the discursive structure: In January 2008, the Soil Association, the biggest organic certifier in Great Britain, declared to ban human-made nanomaterials from all organic cosmetics, foods and textiles that it certifies. For the past few years, the Soil Association has been part of a working-group on an industry labelling scheme, but it has been very unhappy with the reluctant government policies concerning risk regulations: “We are deeply concerned at the government’s failure to follow scientific advice and regulate products. There should be an immediate freeze on the commercial release of nanomaterials until there is a sound body of scientific research into all the health impacts. As we saw with GM, the government is ignoring the initial indications of risk and giving the benefit of the doubt to commercial interest rather than the protection of human health” (Soil Association 2008). It may be a question of time, until resistance to nanotechnology will grow stronger – is this an antagonism à venir?

6 Conclusion

The aim of this paper was twofold: In a first step, tentative and explorative thoughts on an interdisciplinary *hegemony- and discourse-theoretical inspired political economy* approach have been delineated. In a second step, this theoretical matrix has been applied - still cautiously and exemplarily - to the policy field of nanotechnology. The theoretical approach provides a

different perspective on the development of nanotechnology. While most of the current analyses treat nanotechnology as a definite technology, my thesis is that the term nanotechnology denotes an encompassing political project - a techno-socio-economical innovation strategy, that is kept together only by the empty signifier itself. Thus, a perspective is inaugurated that facilitates to delineate political interests and strategies within the process of nanotechnology development. Furthermore, it is possible to expound different discourses and policy narratives that have been associated with the nanotechnology discourse. While the discourse of international competition is fostered through the trope of the ongoing nanotechnology race, nanotechnology itself is presented as one of the most important strategies of innovation to win the battle for global market shares. To become hegemonic, a certain convergence of discursive elements is necessary. The success of the nanotechnology project derives from an alignment with the discourse-organisation of the competition state in general and the narratives of the knowledge-based economy, the nanotech-race and the immense future markets for nanotechnology. These discourses are mutually reinforcing and strengthening.

To a large extent, the development of nanotechnology is shaped by governmental technology policies (even though private actors become more and more important). Today, these policies are predominantly characterised by an accelerating commercialisation. From this perspective, nanotechnology is *the* pre-eminent factor for achieving innovation and competitive advantages: It introduces new goods and offers a new quality of goods, it ushers new methods of production, it opens new markets, and, it offers a new source of supply of raw materials. However, the enforcement of new technologies is no automatic, self-evident process. It rather is embedded in social relations and has to be backed by political measures. Nanotechnology

has to be embedded in modified governance structures, which currently materialise in the political form of the competition state. For this new mode of socio-economic regulation the "consent of the ruled" is required. Regarding nanotechnology, different strategies are performed to win the concurrent "perception wars". Nanotechnology advocates in governments must pursue policies supporting a positive climate for business *and* a favourable public perception. Therefore, they try to invoke different discursive elements in order to strengthen the perception that nanotechnology is indispensable for an economically viable society. While the future for the nanotechnology project is still uncertain, the policy field remains challenging.

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Ethnography of a Paper Strip: The Production of Air Safety

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received 30 March 2008, received in revised form 23 May 2008, accepted 28 May 2008

Abstract

Why does air traffic control still rely on paper control strips? Is paper safer? This question has been dealt with before, and responses have pointed out that "paper has helped to shape work practices, and work practices have been designed around the use of paper" (Harper & Sellen 1995: 2). The present contribution tries to further specify these claims. At first, the use of paper as a medium of representation in the course of dealing with critical situations will be discussed. Drawing on ethnographic fieldwork carried out in two European Upper Area Control centres, practices linked to the puzzling persistence of the paper strip are then captured along with different types of critical situations. Extending the observation of practices to meso- and macro-levels, it can be shown that paper strips are multiply embedded. They help to stabilise cycles of practices, the permanent reproduction of which is critical to air safety.

1 Introduction

Air traffic control relies on local activities carried out in regional control centres. These centres are faced with a major problem of coordination: It is their mission to handle "conflicts", which may lead to the mid-air collision of aircrafts. In order to contribute to the securing of air safety, they draw on two different sorts of information. First, they are provided with anticipatory information generated by a central (European) flight planning unit on flight routes to be taken by aircraft. This information is made visible on flight strips. Second, control centres are equipped with radar screens, which display the actual movements of semi-autonomous aircraft within a circumscribed geographical sector. The situated practices of mediating between the orders of events, as prescribed and observed in real time, have been a subject of numerous ethnographic field studies. More or less rooted in the ethnomethodological tradition (Suchman 1987, 1993), air traffic control centres may even be said to be one of the seminal cases for an approach known as Workplace Studies. Starting in the late 1980s, in-depth field studies have been carried out in a number of European countries, most notably in the UK (Harper et al. 1989, Harper & Hughes 1993), in France (Gras et al. 1994), and in Sweden (Sanne 1999). Drawing on ethnographic fieldwork carried out in the Upper Area Control centres of Reims (France, March 2001) and Karlsruhe (Germany, April and October 2001), the present article contributes to this corpus of research.¹

If the case of air traffic control has attracted attention and gained prominence beyond a highly specialised re-

search community, this is because of the flight control strip and its unlikely persistence: Why is it that air traffic control still relies on paper strips?² Is paper safer (Mackay 2000)? In order to seriously address this question, a few details on the use of flight strips must be presented. Flight strips measuring 13,5 cm by 2,5 cm are printed out about 20 minutes before an aircraft enters the geographical sector a control team is in charge of. Each of them is put on a plastic support and then placed on a rack, which contains as many strips as there are aircraft already in the sector and due to arrive in the sector. A "control team" is composed of two controllers working next to each other.

R TALAL	190	320	M A321	EDDM LFPG 0931 48
0949 ALB	1		VC 4751	UL610 LOHRE
3				UL984 BOMBI
MUNICH		250	A3721 450	IZ BI 0953

Figure 1: Flight strip as used by the Upper Area Control Centre of Karlsruhe, Germany (source: Milde 2007)³

Flight strips contain a wide range of information. To start from the centre, "VC 4751" indicates the flight code. It states that the aircraft is operated by "Voyageur Airlines". Directly above, the type of aircraft is identified: "A321" is for "Airbus 321". The upper line of the right column provides information on the origin (Munich, "EDDM") and the destination (Paris Charles-de-Gaulle; "LFPG") of the flight. Split up between the third row in the left column and the last row down in the right

¹ I would like to thank air traffic control staff at these centres for their reception and interviewees at various divisions of ATC (air traffic control) organisations for accepting being interviewed. Also, I am grateful for the criticisms and comments by two anonymous reviews on an earlier version of this paper.

² The French popular science magazine *La Recherche* has regularly covered this issue (for instance issue no. 319, April 1999, pp. 52-70). The paper strip serves as a display case of what has been called the "myth of the paperless office" (Gladwell 2002). In a more recent *Business Week* cover story, paper strips are used to illustrate the anachronistic technical infrastructure responsible for dramatic bottlenecks in a fast expanding world of air transport (Palmeri & Epstein 2007: 52).

³ With the exception of the centre of Maasricht, all area control centres in charge of the upper part of the German airspace rely on paper strips.

column, the flight strip denotes that the aircraft will enter the sector at 9.49 am ("0949") and leave at 9.53 am ("0953"). Within the sector, flight VC 4751 will have to pass two points of intersection named "TALAL" and "ALB" (left column). There is one minute of flight between these points of intersection, and three minutes before the aircraft is handed over to the adjacent sector in charge of another German control centre situated in Langen ("LANGI"). Scheduled to reach a cruising level of 32,000 feet ("320" right half of the second column), the aircraft has entered the area covered by the Karlsruhe centre of control at an altitude of 19,000 feet ("190"). The centre of Langen expects it to be handed over at an altitude of 26,000 feet ("260", bottom right of second column). Now, if there were a second control strip announcing a second aircraft for one of the points of intersections at the same time and same altitude, the controller would be left with some 20 minutes to "coordinate" this situation of "conflict". A possible solution might be to call the pilot of the first aircraft to change altitude. Having received confirmation by the pilot, the controller would then take a pencil to cross out "190" and write down the "coordinated" altitude on the paper strip instead.

In effect, the example on how controllers use flight strips while coordinating "conflicts" has only been provided for purposes of introduction and illustration. It serves to illustrate the approach taken by Workplace Studies. Having accumulated a larger number of observations on the many ways paper strips are used and manipulated by controllers, Richard Harper and Abigail Sellen have pointed out that paper-based control strips have physical properties difficult to replace by other media of representation. They conclude that "paper has helped to shape work practices, and work practices have been designed around the use of paper" (Harper & Sellen 1995: 2). While both claims have become commonplace within Workplace Studies and adjacent

areas of research, I will argue that both claims are – still – waiting for specification. In order to explain why it is so difficult to divorce practices of air traffic control from paper strips, the present contribution suggests taking three steps of analysis. The first step (section 2) is to theorise the use of paper in terms of a medium of representation in the course of dealing with more and less critical situations. The problem of representation of both accidents and normal operation needs to be theoretically reflected; and this reflection goes beyond the habits and the present corpus of Workplace Studies. In a second step (section 3), I will turn to the empirical level of the analysis and present the issue of the paper strip in its organisational contexts, including that of the collaborative research project the present contribution draws on. This is a necessary prerequisite to specify practices, which have co-evolved with the use of paper strips (section 4). It is the analytical distinction of the "cyclical" nature of practices, which helps to identify practices of different scale and scope. This extension of the notion of practices to meso- and macro-level observations may be seen as an achievement in itself. In addition, it prepares for a return to the problem of representing normal operations, which has been theoretically reflected in a previous section. The conclusion reached in this study (section 5) is that paper strips are multiply embedded. They help to stabilise cycles of practices, the permanent reproduction of which is critical to air safety.

2 Organisational ethnography: the *active* production of safety

This section discusses a shift in the understanding of safety. If safety is identified with the absence of accidents, the representation of critical situations is (nothing but) a matter of hindsight. A perspective, which highlights the active production of safety, in contrast, requires examining the

role of different media of representation and the way they are linked to specific practices. Here, I chart how the latter view has emerged from the former, which prepares the ground for subsequent empirical analyses.

Dealing with technical failures and accidents, social studies of technology and risk have often highlighted that their representation is a matter of hindsight. It would therefore be simply erroneous to think that accident representations established post hoc provide significant information on the conditions facing the operators in a situation of crisis. The problem of hindsight persists regardless of whether technical systems have been equipped with failure-proof technologies of recording and conserving accident data. Even black boxes containing flight data and cockpit voice recorders which are designed to withstand the crash of an aircraft sometimes fail or do not contain reliable data on the course of an accident (Potthast 2006). If there is a single major achievement in the social sciences within the area of risk research, it is the way in which the idea of a perfectly neutral medium allowing for unquestionable representations of accidents has been challenged. This is why the "black box" has enjoyed particular attention in this area of research and has even become a metaphor to characterise its constructivist approach. At some point, "opening the black box" had become a standard analytical operation. While this has undeniably helped to integrate a social science approach to the study of technology and risk, its success may have caused the demise of its analytical power. According to the critical diagnosis of Langdon Winner, constructivist research on technology and risk had become irrelevant as early as the 1990s, restricting itself to a critical gesture of repeatedly "opening the black box and finding it empty" (Winner 1993).

In the past, sociological research has struggled to capture "accidents" as a legitimate object of inquiry.⁴ However, social studies of technology and risk have flourished, not content to focus on a ritualised questioning of hindsight (of accident representations). In the following, I will discuss some approaches that have escaped a narrow conception of accidents and developed an alternative view on how to deal with critical situations. Among the approaches which have somehow managed to deactivate the problem of hindsight, one has to mention the work by Charles Perrow. His book on "normal accidents" (Perrow 1984) has had a major impact as it shifted from viewing accidents as single events to their inner dynamics. Having discovered that technical failures and breakdowns followed different sequential patterns, Perrow launched a comparative research program on different technologies. Once reconceived of as sequences of events rather than indivisible events, accidents can be shown to leave more or less scope and time for interpretation and intervention by users and operators. According to Perrow's conclusion, this scope for diagnosis and reaction depends on the objective characteristics of technical systems. Following this account, the problem of hindsight can no longer be generalised and may be reformulated. Hindsight is a matter of degree, depending on different types of system design. Read as a strategy to tackle the problem of hindsight and to capture accidents as an object for sociological inquiry, Perrow's study has three implications, which have become signposts for subsequent research. First, the problem of post hoc representation has been specified in terms of its recipients.

⁴ According to Judith Green, "sociology has largely ignored accidents as a legitimate object of study. This (...) neglect is not mere coincidence but an inevitable outcome of the ways in which accidents have been constructed. When they have been studied, accidents have been redefined as 'non-accidental'" (Green 1997: 15).

Hindsight is not a problem to an abstract observer or the imagined general public but to the operators of technical systems. Second, the notion of hindsight is re-defined. Only if leaving no room for interventions, representations of accidents are counted as representations with hindsight. Third, the definition of accidents is extended to potential accidents or accidents which have been prevented.

Developing independently of the "normal accident approach", there has been a second stream of research originating from a North American campus, which has succeeded to by-pass the problem of hindsight. Its focus is on "highly reliable organisations", or "HRO"; that is organisations which run risky technical systems often without ever having produced an accident (La Porte & Consolini 1991, Rochlin 1993). According to the HRO approach, this outstanding performance of actively producing safety requires explanation. By implication, safety is no longer defined as the absence of severe accidents. In accordance with the adherents to HRO, who claim that this is a poor and passive understanding of safety (Rochlin 1999: 10, 2003), the central question is no longer "how do organisations prevent that accidents occur?", but rather "how do organisations deploy which modes of representation in order to anticipate accidents?"⁵

This is a tricky question if one takes into account that control room personnel relies on representations of technical failures, which are themselves ex-

posed to technical failure. This phenomenon, referred to as second order failure (Hirschhorn 1984), calls for differentiation of the notion of breakdown and failure, which is highly relevant to the case of air traffic control. As illustrated by the subsequent sections, air traffic controllers cannot directly access first order failures. They live in a virtual environment, fully dependent on media of representation, and are therefore exposed to second order failures. Given this dependence, one has to take a closer look at how the respective representations are used to anticipate and respond to critical situations. To attribute primacy to any single medium of representation would be unfounded. This will be strikingly illustrated by the case of air traffic control (to be introduced in the following section). This empirical case emphasises that the analytical challenge consists in capturing the coexistence of different "medialities" having diverse properties. Rejecting the idea of an *a priori* convergence of media, one needs to search for an alternative way to explain why technical systems are operated reliably, despite their management being divided up between different media.

In the field of social studies of technology, many authors have argued in favour of a "difference of media" hypothesis (Latour 1991, 1996, Rammert 1998, Schüttelpelz 2006, Strübing 2006). Many of these contributions, however, have failed to provide empirical analyses along with a challenging theoretical program. In order to cover this research lacuna, I have suggested focusing on breakdowns or accidents waiting to happen, thereby transforming the normal operation of technology into a more exotic species (Potthast 2007). Studying how organisations cope with breakdowns and failures, "normal" operations appear less orderly. "Accidents and their subsequent inquiries are perhaps the only passing moment when outsiders may glimpse the routinely less orderly, less rule-controlled world of technology

⁵ For an overview on the HRO approach, see Roberts (1993). Air traffic control has been among the first and favourite objects of inquiry of this approach (La Porte 1988). For more recent publications taking a similar perspective, see Vaughan (2005) on air traffic control and Bourrier (1999, 2001) and Perin (2005) on controlling and maintaining nuclear power stations. A major study on air traffic control based on long term ethnography and some 180 interviews in four air traffic control centres in the US is underway and carried out by Diane Vaughan.

and science. However, because it is seen this way only around accidents, the belief is consolidated that normally practices are more orderly" (Wynne 1988: 150). Ethnographic analyses of normal operations have to keep accidents at an analytical distance. Otherwise, analysts would fall back into an explanatory scheme opposing rules (explaining normal operation) and exceptions (explaining accidents, thereby confirming the primacy of rules), which cannot be taken for granted. Technical systems are operated by highly specialised experts who have often developed remarkable skills and routines in coping with critical situations. However, in building up these routines, communities of practice contribute to shift the definition of rules (Vaughan 1996, 2002). In short: "[p]ractices do not follow rules; rather, rules follow evolving practices" (Wynne 1988: 153). By consequence, it may be deviations from the rule, tolerated by a community of practice, which contribute to reliably operating technical systems (Ortmann 2003). At the same time, tolerating deviations from the rule may lead to the emergence of practical rules. This line of argument has allowed for an alternative account of accidents and incidents. There may be accidents although everyone involved in the process has stuck to the (emergent set of practical) rules. "Working in practice but not in theory" (La Porte & Consolini 1991)? Confronted with accidents which cannot be accounted for in terms of a violation of rules? Faced with the reliability of normal operations which cannot be explained other than in terms of violating rules? Given these paradoxes, I suggest to abandon the focus on "accidents". Instead of taking rules and their exceptions for granted, I will rather speak of "critical situations" which need to be approached by means of ethnographic inquiry.

Taking the problem of hindsight as a point of departure, the present section has theorised on the status of (different) media of representation for ex-

plaining the reliable operation of complex and risky technical systems. This reflection has gone beyond the current corpus of Workplace Studies in order to prepare for a more specific explanation of a puzzling empirical phenomenon: Why is it so difficult to divorce practices of air traffic control from paper strips? I will now turn to the empirical level of analysis. The following section puts the paper strip in its broader organisational contexts and retraces a recent chapter in the long history of its failed replacement. Contrasting this story of failed research and development efforts based mainly on interviews and documentary analyses, I will then draw on in-depth ethnographic observations in order to specify practices, which have co-evolved with the use of a specific medium of representation (section 4). Both sections are based on field reports I contributed to a collaborative research project (Potthast 2002).

3 The organisational context of the paper strip and of the empirical fieldwork

The large technical system of air transport has a remarkable record of availability. Air traffic has experienced local shut-downs due to bad weather conditions, war or terrorist attacks, but it has never come to a global standstill.⁶ How to account for the safety record of air traffic control? How to explain the small number of plane crashes air traf-

⁶ In 1981, a strike of air traffic control brought the North-American airspace close to a complete halt (Nordlund 1998). Twenty years later, on 11 September 2001, the same continent came to its first standstill of civil air transport in history. Air traffic controllers were ordered to land about 4,500 planes in a few hours (9/11 Commission 2004: 46). According to the 9/11 report, among the authorities involved in responding to these terrorist attacks, air traffic control was the only agency that deserves praise for its performance. Carrying out the unprecedented task of safely landing an enormous number of aircraft, "[t]hey have been superb" (ibid.: xvii).

fic control has been made responsible for? Although offering some insights to the organisational contexts of air traffic control in Europe, the present section does not yet provide an answer to this question but adds many aspects, which make the achievement of safety in air traffic look very unlikely. Pre-supposing that readers are not familiar with the processes of air traffic control, the section is set up as a guided tour of this world, arranged in a conventional mode of ethnographic accounts. Its story-line is the biography of a research and development project in which I have been involved, thus including reflexive elements.

The present contribution is based on ethnographic fieldwork and interviews carried out in the context of a larger international collaborative research project (named "LOOK"). Commissioned by the Eurocontrol Experimental Centre, which long ago adopted the view that paper strips must be substituted, a large research consortium was established to prepare for a multi-dimensional testing procedure. Supposed to prepare grounds for a systematic comparison of different working positions in terms of safety, the project was expected to support the development of *digital* control strips as a medium of representation.⁷ Constructing

a comparative simulation that delivers legitimate proof turns out to be a demanding task. It calls for a more thorough investigation of the role of media of representation in critical situations (outlined in the previous section and carried out in section 4).

3.1 First stop: Eurocontrol Experimental Centre

The Eurocontrol Experimental Centre is located next to a former military airport at Brétigny. South of Paris, but badly connected to public transport, we are picked up at a local train station by an employee of Eurocontrol. It is the first time I have been in a car assigned diplomatic status. I am once more impressed with my first view of the research facilities of Eurocontrol. Having been the last to arrive at the research facilities, we are seated in a bright and modern conference room. Some twenty persons present themselves as experts in such fields as cognitive sciences, ergonomics, information sciences, human-machine interaction. Their affiliations range from Paris-based university labs to university hospitals, civil and military governmental research organisations. The session is coordinated by two Eurocontrol researchers who start off with a surprisingly tight schedule for what they call a "multi-dimensionally validated simulation of different alternatives of controller environment (paper strip, Digistrip and stripless)".⁸ Later in the discussion, the official project

⁷ I was contacted by CETCOPRA (Centre de Recherche des Techniques, des Connaissances et des Pratiques), a Paris-based research group, to take part in this project. Firmly rooted in more than a decade of extensive fieldwork, CETCOPRA has established an unusual blend of sociological and anthropological approaches to technology (cf. Bowker 1996). Ethnographic fieldwork has been carried out in the cockpits of civil and military aircraft (Moricot 1997, 2004); it has covered the development of new aircraft (Scardigli et al. 2000), aircraft maintenance (Moricot 2001), the innovation of air traffic control systems (Poirot-Delpech 1995) and their maintenance (Martin 2000). Sites of ethnographic inquiry further include air traffic control rooms (Vongmany 1998) and training facilities for pilots and air traffic control staff (Dubey 2001a, b). There is even an ethnographic study devoted to working conditions of cabin personnel accompanying

long-haul travel (Dubey et al. 2000). Bringing together some of these different professional and organisational perspectives on the operation of air transport, a first synthesis study was published in 1994: "Faced with automation: The pilot, the controller and the engineer" (Gras et al. 1994, cf. Gras 1989). About the same time, extending towards more theoretical and historical ambitions, "Grandeur et dépendance" (Gras 1993, cf. Gras 1997) became *the* French contribution to the then emergent approach on "Large Technical Systems" (Joerges 1988).

⁸ See Eurocontrol Experimental Centre Annual Reports (2000: 33, 2001, 2002) and Grau et al. (2003).

title is shortened and referred to simply as "the simulation".

During a break, I meet Mr H. who is closely familiar with the Digistrip development project. Thanks to his initiative, I have an opportunity to be introduced to the then current version of Digistrip. It is basically a large touch screen modelled after the rack conventional paper strips are placed on. In terms of flight data displayed, digital flight strips do not differ from the conventions explained in the introductory section. Each digital strip contains information on a single flight. Placed in two rows on the rack (which is now a screen), digital strips can be sorted and re-sorted by slightly moving fingers on the surface of the screen. According to Mr H., the Digistrip and its screen conserve working routines that have developed around the paper strip. This includes registration of inscriptions written on the screen. What is more, Digistrip is equipped with a recognition program which identifies a number of symbols (numerals and characters). This is why Digistrip promises to close the information loop left open by paper strips as illustrated earlier.⁹

3.2 Second stop: European skies as a political arena

If successful, the simulation would take Eurocontrol's interest in replacing paper strips by digital flight strips a step further. Undeniably, the supporters of the digital strip have a salient argument. Provided that it comes with a reliable technology of script recognition (for instance of notations regarding flight altitude, see introduction), digital flight strips would allow for a feedback of information into the system in real-time. This, in turn, is seen as a considerable improvement in the level of interoperability within air traffic control, a key mission for Eurocontrol.¹⁰ Table 1, comparing the organisation of European and North-American air traffic control services, is often used to illustrate the European challenge of ensuring interoperability.

While being of comparable size and counting a comparable number of hub airports, the structure of European airspace is much more compartmentalised than its US counterpart. As shown by table 1, Europe has 47 organisations responsible for air traffic control (while the US have only one); 58 Upper Area

	US	Europe
Airspace [million km ²]	9,8	10,5
Hubs	31	27
Civil and military air traffic control organisations	1	47
Upper Area Control centres	21	58
Operating systems	1	22
Program languages	1	30
Air traffic control costs per flight [US-\$]	380	667

Table 1: The divided European sky (source: Zetsche 2004)

⁹ There is a range of developmental projects on digital strips attempting to conserve the advantages of paper-based environments (Mertz et al. 2000, Guichard 2001, Durso et al 2005). Digistrip has been developed by CENA (Centre d'Etudes de la Navigation Aérienne), a research centre of the French Ministry of Transports, and has been re-branded "Vigiestrip" (Pavet et al. 2006).

¹⁰ At an early stage, Eurocontrol had to abandon its initial mission to create a single European sky. Having reframed its mission since then, it now cares for the interoperability of a European airspace which continues to be divided. Both, the history of divided skies (Bremer 1976), and the interrelated history of Eurocontrol (Eurocontrol 1993-2003), are still waiting to be analysed in detail.

Control centres in Europe compare with only 21 in the US. European control centres employ 22 different operating systems and 30 different program languages. In the US, there is only one operating system and one programming language. Reportedly, these differences are reflected by the respective costs. Air traffic control

Among others, the centre of Karlsruhe was expected to send controllers to take part in the simulation to be arranged by the research consortium, commissioned by Eurocontrol. This is why I was invited to do ethnographic fieldwork at this particular centre. Furthermore, I had the opportunity to accompany Gérard, member of the

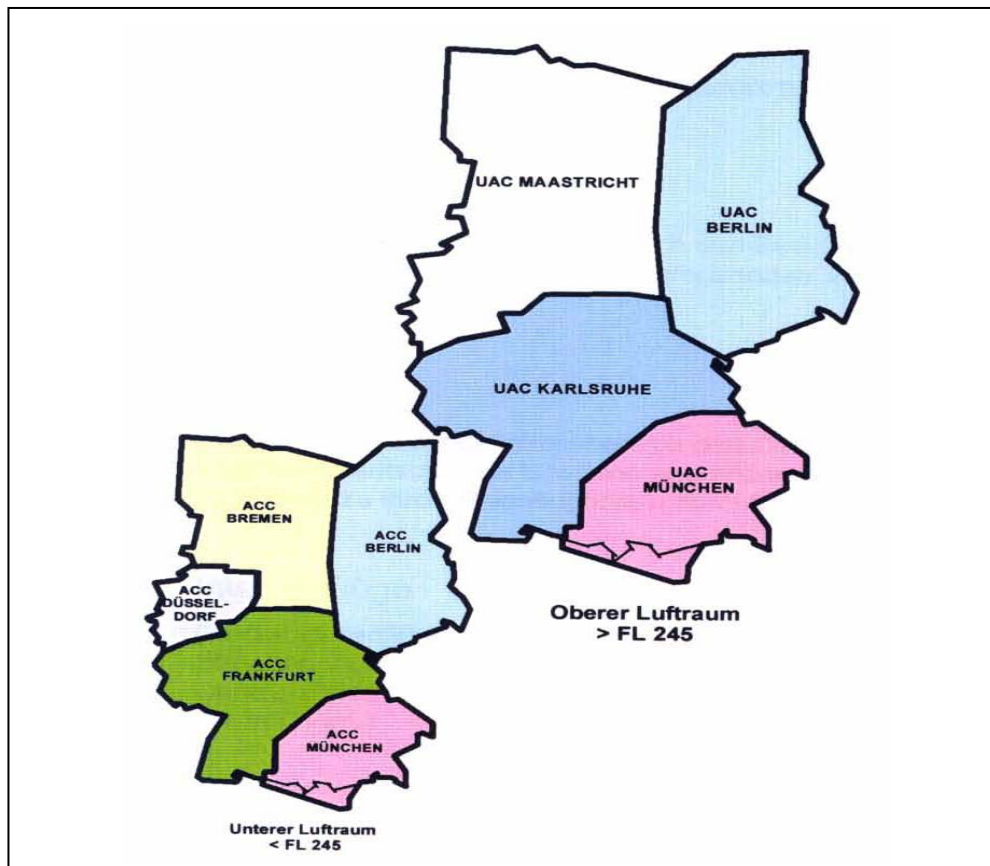


Figure 2: Horizontal and vertical organisation of Air Traffic Control in Germany (source: DFS 1997)

costs in Europe amount to 667 US-Dollars per flight. In the US, the price of a safe flight is 380 Dollars. This difference in costs is very significant considering that the German airspace alone accounts for three million flights per year.

Figure 2 shows how the German airspace is organised. Vertically, it is divided up into an upper and a lower slice; in its horizontal extension, it is split up between a number of geographical sectors. Figure 3 shows the upper area sector controlled by the centre of Karlsruhe ("Rhein Radar").

CETCOPRA team, spending several days at the Upper Area Control centre of Reims.

3.3 Third stop: The repetition of critical incidents

During this field trip, we meet an experienced controller who has recently provoked a near-miss. He takes us with him to a working position the only purpose of which is to recapitulate critical incidents. Together we are watching the short critical sequence, again and again. Unsurprisingly, we struggle to seize the severity of the

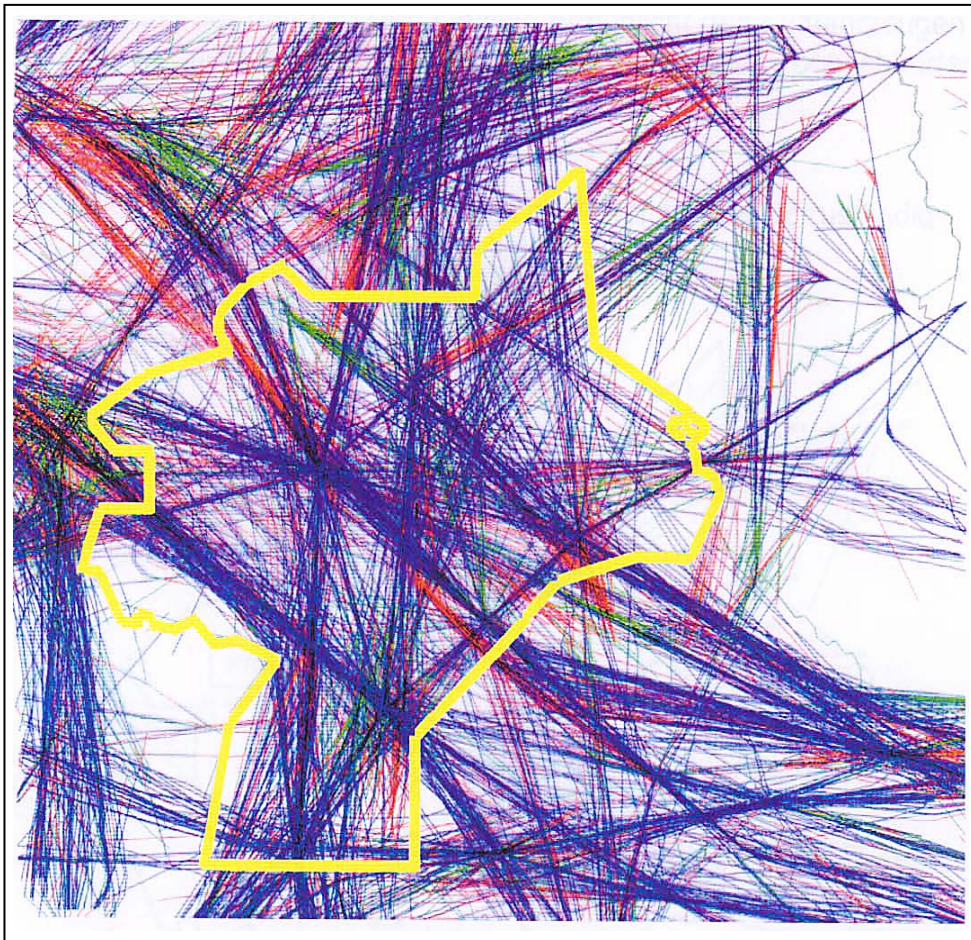


Figure 3: Flights controlled by the Upper Area Control Centre of Karlsruhe (source: DFS 1997); the charts show flight paths, colour-coded by departures (red), arrivals (green) and en route flights (blue)

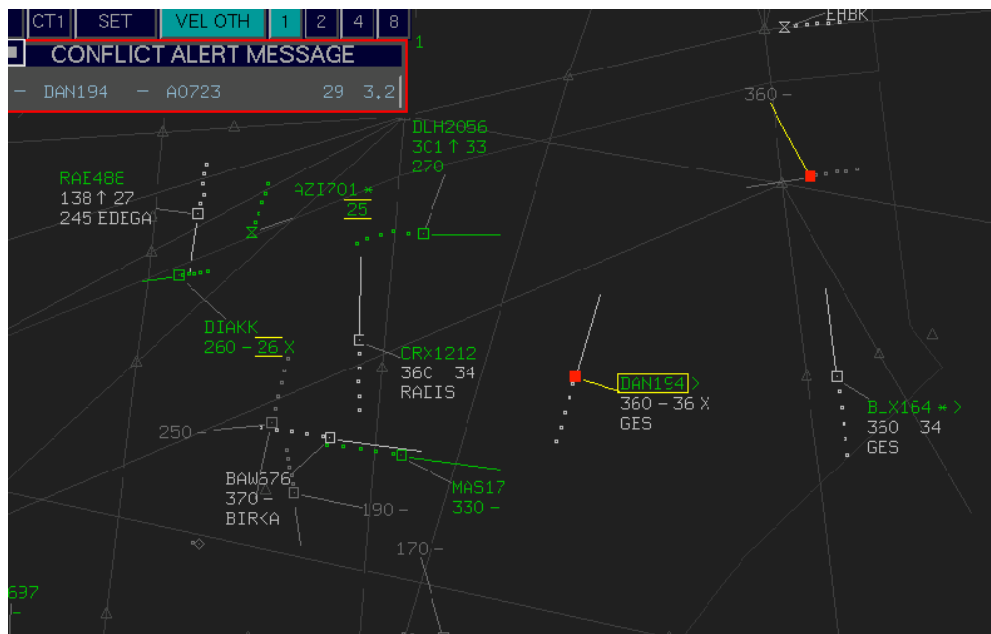


Figure 4: Conflict alert message displayed by air traffic control radar screen (http://www.eurocontrol.int/nuac/public/standard_page/PDphotoGallery.html, downloaded 20 Nov. 07); see also the Atlanta Terminal Approach Control centre which provides live monitoring online (<http://atcmonitor.com/>, latest view on 30 March 2008)

situation for its representation, by radar images and recorded radio calls, remains rather distant and virtual.

The two needles highlighted in red (cf. figure 4) represent two aircrafts which are flying at the same altitude (36.000 feet). As they are calculated to arrive at the same time at a point of intersection, air traffic control needs to step in and handle the potential "conflict". The emphasis on paper strips should not obscure the fact that air traffic control is also based on radar screens. Controllers are provided with a double representation of their area of responsibility. As stated before, there are always two controllers in charge of a sector. On average and during the daytime, they have to simultaneously keep an eye on about 15 flights.

On the radar screen, each flight is represented by a needle indicating the direction of the aircraft (cf. figure 5). The length of the needle correlates with the speed of the aircraft. Calling "DLH123", the controller can establish radio contact with the pilot. "330", once again, indicates the current flight level, and "<F" tells the controller that the plane has started in Frankfurt.

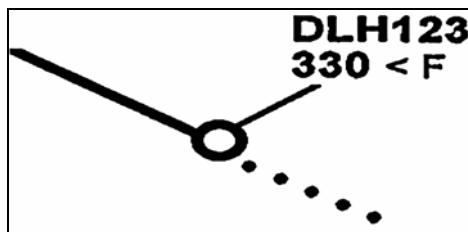


Figure 5: Representation of an aircraft by air traffic control radar screen

3.4 Fourth step: The division of technical support

Arriving at the Karlsruhe centre, I am met by Mr. L., a former controller who

is now managing the technical support division. He describes his job as a constant challenge consisting of two tasks: first, to stay close enough to everyday operations to understand its manifold requirements; and second, to carefully guide the centre through the inevitable technological improvements. Carrying out this task, he has to mediate between two spheres of activity both of which tend to be closed worlds. While many centres have been trapped in a process of divorcing "operations people" from "technical people", Mr. L. claims that Karlsruhe was lucky to escape this separatist trap: For a particular historical reason, it is the only German centre to have an in-house development team. This team is said to have "grown up" with the system and taken care of its development for decades. All interviewees confirm this view. Following the path of in-house technological development and locally adapted implementation, the Karlsruhe centre is presumed to have a long-term regional advantage.

3.5 Fifth step: Control room

Inside the control room, I am often reminded of Mr. L.'s motto. He needs to do everything in order to prevent the controllers' sense of safety from being negatively affected. This implies adhering to high standards of transparent communication and avoiding any kind of behaviour, which could lead to barriers of communication or mutual blame. Most importantly, controversies about the right path of technological development must be kept out of the control room.



Figure 6: Air traffic control room (source: DFS 1997)

In a word, the operations room must be free of conflict – and this indeed is the case! Whenever I am in the control room, during day or night shifts, controllers behave towards each other at a strikingly high level of professional sincerity. There is no sign of ambiguity or aggression. The rules of socially competent and fair behaviour seem to be clear and undisputed. It adds to this impression of sincerity that no opportunity is missed to greet each other and to shake hands. Whoever visits the control room, for whatever purpose, is carefully introduced.

In many respects, the control room was quite accessible for carrying out an ethnographic program which I have developed elsewhere (Potthast 2007: 87ff.). Within the flow of work practices, there are moments of increased attention. These are easily distinguishable from routine action. Signals of increased attention and nervousness multiply; lowered voices; curt phone calls ("call you back!"); requests for repeating messages. A control team facing a difficult situation is often joined by colleagues standing behind them and observing what is happening.

In such cases, they stay at arm's length and act in a perfectly unobtrusive manner. If asked, they are capable of explaining what has happened.

Notwithstanding these informal gatherings, air traffic control is carried out by teams comprised of two persons. Each team is in charge of a geographical sector and provided with two different modes of representations. On the one hand, there are radar screens, on the other hand, each of the working positions ("suites") has paper strips placed on a rack. When a new paper strip comes in, it is put on the rack according to two simple basic rules.

First, it is placed next to those flights heading for the same (few) points of intersection. The second principle of the sorting order is simply chronological. Following both principles, strips are constantly re-grouped. As described earlier, some flights need to be coordinated. In this case, changes of direction, altitude or speed are written on the respective flight strip.

Finally, there are distinct job descriptions for the two positions of a control team. Placed on the left side (cf. figure

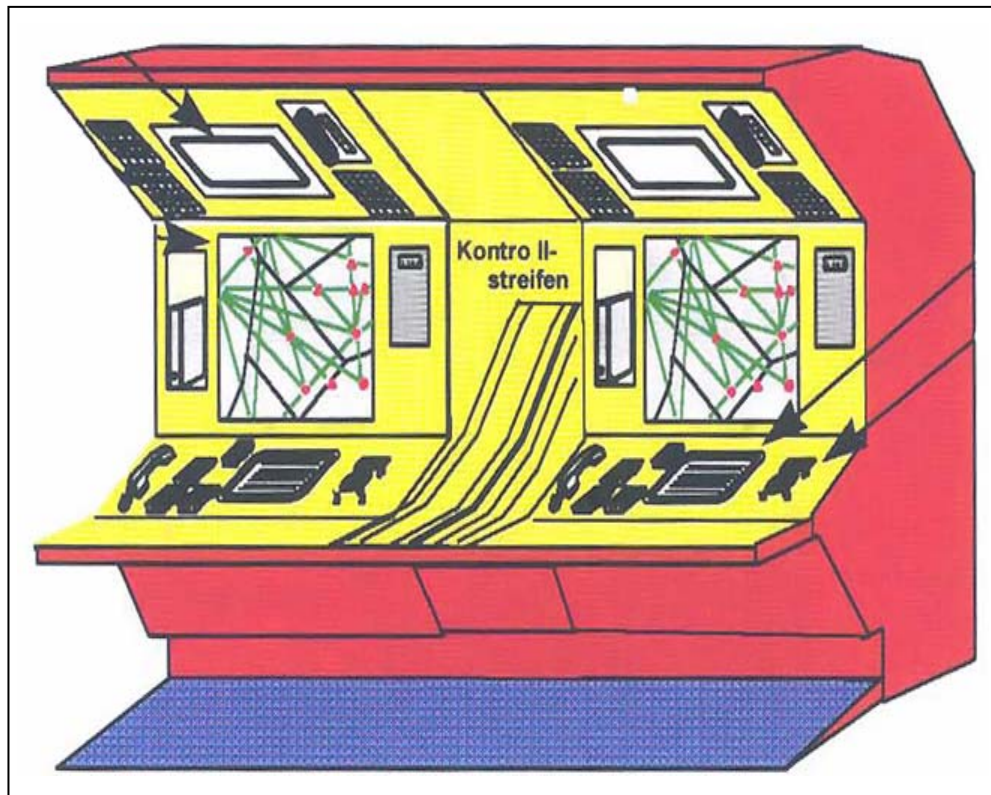


Figure 7: Air traffic control "suite" (source: DFS 1997); a typical air traffic control working position is designed for two persons and equipped with radar screens and a rack for flight progress strips ("Kontrollstreifen") in the middle; there is a controller position on the left and a coordinator position on the right

7), "The radar controller is in charge of identifying and maintaining the destination of flights. He has to (...) declare clearances and give orders to ensure that minimum separation between aircraft is respected at every time and to document these activities on the flight strips" (DFS 1997: 4; my translation). To his right, "the coordination's controller is in charge of collecting and distributing information. He approves on taking over flights from adjacent sectors and is in charge of the handing over by radar. Based on control strips, he produces and keeps an up to date image of the traffic situation. He announces potential violations to minimum separation to the radar controller (...)." (ibid.: 11; my translation).

3.6 Sixth stop: Seminar room

If there is a single space in which the worlds of operations people and technical people overlap, it is the seminar rooms. Controllers are frequently requested to attend presentations on

diverse subjects related to their work, be it a future re-organisation of sector boundaries or the introduction of a new software package. Taking part in one of these seminars, actually on the introduction of "Reduced Vehicle Separation Minima" (RVSM), I am struck by the overly didactic and highly ironic style of presentation. In terms of atmosphere, it is hard to imagine a sharper contrast to the almost assiduous sincerity encountered in the control room. The presenter anticipates this, delivering a remarkable performance of self-irony. His visual presentation consists of a close sequence of well-prepared didactic elements. However, permanently interrupting himself and commenting on every single didactic clue, he makes it look ridiculous. The public clearly enjoys this performance. Participants are highly responsive, and contribute funny remarks and comments throughout the presentation.

3.7 Seventh stop: The sudden end of a research project

After its first year, the collaborative research project came to a sudden halt. Since then, only one out of three scheduled simulations did take place. The sudden end also implied that the project, conceptualized as a systematic comparison between work practices in different regional centres (i.e., the contribution by CETCOPRA), had to be abandoned at an early stage.¹¹

Organised as a guided tour, the present section has told the story of an abandoned research and development project, which aimed at replacing paper strips by digital strips. Pointing to the practical circumstances of the project rather than to particular uses of the paper strip, it has been shown that there are many reasons to doubt that paper strips will soon be replaced. Provided that the everyday production of air safety is deeply embedded in regional exceptionalism and path dependency, and given the delicate nature of the relationships between operations and technical development, it is a task of extraordinary complexity to build up a simulating and testing procedure, which is consistent and considered legitimate by all parties involved. The next section will provide a more fine-grained analysis of this picture.

4 Cycles of practical activities supported by paper

How is it possible to reliably operate technical systems despite their being divided up between different media? As argued before, adjustment between

different types of technology based on different types of media cannot be taken for granted. Instead, one may expect that this implies a permanent effort of mediation. "Because of their arbitrary nature, languages, bodily techniques and rituals seem to have a tightly restricted potential for accumulating refinement and integration"¹² (Schüttpelz 2006: 104). The observations analysed in the present section focus on paper strips at the interface of extra-somatic and somatic technology. This is what ethnographic studies on air traffic control workplaces have usually done. Consequently, there are well-documented and detailed observations on the uses of paper strips. This has been crucial in developing a new understanding of how air safety is actively produced. However, revealing mediating practices has often remained inconclusive. The present section will therefore go beyond the habits of Workplace Studies and be more precise about the way practices are identified. It will do so by distinguishing different sets of practices by taking their cyclical (or recursive) nature as a common trait and the length and scope of cycles as a criterion for differentiation. Interpreting the empirical material with this analytical device, I have identified four sets of practices presented here in an ascendant order. To begin with, there are observations on the role of control strips for stabilising the shortest cycle of control activity. It is this cycle, which has attracted most attention by former research – at the expense of neglecting the other three.¹³

¹² Translated by the author from the German original.

¹³ The basic material generated and explored in the following pages is about different life cycles of information. This is partly in accordance with an ethnographic convention which has been presented most comprehensively by Richard Harper (2000). It is surprising that while the author often compares different ethnographic studies on different subject areas, his "ethnographic program" seems to be built on the assumption that there is only one cycle of information per organisation.

¹¹ The only reason provided for the decision to stop the project was a financial bottleneck caused indirectly by the attacks of 9/11 (Dubey et al. 2002: 2). The budget of air traffic control is calculated on the amount of air traffic control charges paid by airlines. As a result of air traffic significantly decreasing after 9/11, the revenues of air traffic control including Eurocontrol and its European Experimental Centre were also affected.

4.1 Passage of a plane

Using paper control strips, the work of air traffic control gains a dimension of physical experience. Control strips "are materialising" flight movements; and they do so "one by one" (Gruszow 1999). Paper strips remind controllers of the trivial fact that each aircraft is a discrete entity. A paper strip put on a plastic slide and placed on the rack is a plane entering the control room. A similar observation can be made about a plane leaving the sector. To hand over a plane to an adjacent sector, the radar controller provides its pilot with the new radio frequency. Having received confirmation he simultaneously says "bye-bye" to the pilot and throws away the paper strip. These two gestures mark the beginning and the end of the shortest cycle of control practices. Within this cycle, there are various activities which involve the manipulation of control strips. As described above, the tasks of the two controllers differ and are only loosely coupled. At the same time, activities carried out by the radar controller need to be intelligible for his or her colleague and vice versa. Activities directed at moving or marking paper strips are an efficient way to maintain this level of intelligibility. This is even more obvious as there seems to be no need for oral communication. While doing their work, controllers are rarely seen talking to each other. This is how paper strips work: they stabilise an arrangement of parallel yet related activities. They bring about an element of scansion and rhythm, which contrasts with the type of balanced attention required by watching radar screens. To use a favourite quote of a number of controllers: "Thanks to paper strips, control activities are palpable" ["greifbar"]. To give an example, a controller might put a paper strip slightly on the edge of the rack. This is to signal a potential conflict without having to interrupt or to wait for his colleague who is still carrying out another task. Paper control strips stabilise passages of planes and are used as a medium of communica-

tion facilitating temporally deferred interactions between controllers.

4.2 Hand-over

Some of the partners contributing to the collaborative research project raised a fundamental criticism towards the selection of sequences decided to be relevant for a comparative simulation. They expressed concern that situations in which paper strips matter most may turn out to be impossible to simulate. They argued that limiting simulations to a closed single "suite" (of two working positions) was an unjustified design decision and a questionable limitation. Controllers in Karlsruhe would support this criticism. They report that paper strips are of particular importance when co-presence (of two controllers, as described in the previous paragraph) is interrupted. There is one type of interruption which occurs on a regular – and cyclical – basis: having worked for 90 minutes, controllers are replaced for a break. A smooth hand-over presupposes that a controller who is about to take over responsibility is capable to quickly grasp an overall picture of the current situation. This is when the paper strips, sorted on a rack in a way as to anticipate potential conflicts, are often used. On several occasions, I have observed that, arriving at a control station, controllers use their fingers in order to memorise the representation of their flight sectors. Swiftly touching control strips one by one, and sometimes slightly changing their sorting order, they seem to actively apprehend the situation. Shift work brings with it a second cycle of practices, which is not defined by paper strips but stabilised by their use in hand-over situations.

4.3 Rite of passage

The collection of paper strips serves as a mode of representation, which duplicates the control system by radar. In case of emergency, it may also act as a medium of representation substituting for radar screens (cf. Hutchins 1995). This is a lesson many controllers have

learned by the end of their professional training: Out of the blue, their instructors would switch off the screen. This is a hard test which is said to shortly precede the veritable rite of passage of the "first release": the first time a controller takes full responsibility of a geographical sector (Dubey 2001b: 173ff.). Members of the CETCOPRA research group reported that some instructors went on testing their former trainees by switching off the radar screens and enquiring about the location of planes on the basis of paper strips.¹⁴ These tests are events of high significance for they recall the rite of passage and thereby contribute to reproducing a specific pattern of relationship between more and less experienced controllers. Concerning the issue of medial representation, re-enacting these tests may be regarded as a ritual of distrust. Faced with the test situation, controllers need to distance themselves from a particular medium of representation (namely radar screens) and to switch to the medium of paper strips for compensation. As a result, they might remain somewhat suspicious of the radar screen. In other words, testing is a way of exposing the mediality of a medium.

A rite of passage constitutes and is accompanied by a third set of cyclical practices. Also being stabilised by the use of paper strips, its life cycle is much longer than those identified in the previous paragraphs. By implication, first release experiences and tests are events which rarely happen. Statistically speaking, they are low-probability events. In order to understand their significance, one needs to look more closely at the social pattern in responding to situations of high uncertainty. As illustrated above, controllers may be responsible for causing a near-miss. Although this might happen only once in a controller's lifetime, controllers say they would always recall this event. More importantly, they report that to go through a troubling

situation of high uncertainty is far from being a private experience. Controllers claim to be aware of their colleagues (responsible for adjacent sectors) being "in form" or struggling. This is why it does not come as a surprise when a controller, unable to cope with a complex situation, calls out "stop!" Given the current design of air traffic control, managing (or failing to manage) situations of crisis will never be left unnoticed to colleagues. What is more, the collective dimension in responding to critical situations can be expected to result in a strong social and affective cohesion. According to the analyses of the CETCOPRA group, this is why social organisation in air traffic control centres takes the particular form of "clans" (Dubey 2001b: 195). Following this interpretation, the rite of passage provides a model for how critical situations are managed. "The existence and the mediation of the collective compensates for the quasi-absence or the virtual presence of aircrafts. In other words, controllers catch up on the distance which separates them from the sky and from the reality they are acting upon (...)"¹⁵ (Dubey 2001a: 13).

4.4 Generational change

Interviewees at the Karlsruhe centre are convinced that Digistrip, as prepared and tested by Eurocontrol, is incompatible with a future operation system all German air traffic control centres are waiting to be equipped with. This is why the Karlsruhe regional centre would not openly opt for Digistrip. In the light of this macropolitical constellation, both the simulation and the future of Digistrip do not look very promising. But interviewees also let me know that they are confident to find a way to locally develop a new version of Digistrip which would be adapted to the specific requirements of that centre. If this vision was implemented, the Karlsruhe centre would

¹⁴ Thanks to Gérard Dubey for sharing this observation.

¹⁵ Translated by the author from the French original.

again demonstrate its commitment to always opt for fully tailored solutions and never become dependent on external expertise.

If asked whether Digistrip will be introduced or not, interviewees answer by embedding this question into a larger political framework. Without going into details, these accounts help to explain why I did not come across a single voice of dissent or a single sign of resistance against the idea of turning paper strips into digital strips. It seems to be more important and a reason of confidence that the regional centre is able to integrate the issue of Digistrip into the particular Karlsruhe success story. If there was no doubt about the centre's exceptionalism, there would be no reason to worry. Confidence, however, is paired off with a gloomy picture. The local success story might soon come to an end as the generation that has developed the system from scratch, and has been in charge of its maintenance since then, is now close to retirement. Particularly, this applies to the head of the software development team who is said to personify the generation which grew up (with) the system and who is said to "live the system".

The preceding paragraph on the "rite of passage" has dealt with an element which is part of the training of air traffic controllers. It has to be said that in the age of simulators, this particular exercise looks as if it was part of an antiquated didactic repertoire. Observing changes in the process of training, controllers of the senior generation express a deep concern that the rise of the simulator comes with the demise of a more interactive professional training. They already feel surrounded by a new generation of controllers labelled "the Nintendo Generation". Members of this generation are said to be no longer rooted in aviation and therefore to be deprived of an appropriate cultural orientation. Among those, who claim to have enjoyed full training, it is common to criticise that current training practices fail to take into account

the interface between pilots and controllers. To bring evidence to this criticism they point to the fact that training sites, which once included airports, are now situated far out in the countryside. It should not come as a surprise, therefore, that younger colleagues no longer had a "system's perspective" as they had grown up and in a synthetic world. The younger generation is supposedly condemned to act in a synthetic world, which is said to "lack depth" and will neither object to digital strips nor defend the Karlsruhe exceptionalism. Members of the older generation testify that they "cannot imagine working without paper strips". However, with a generation moving towards retirement, the paper strip will probably disappear. As opposed to the observations reported and interpreted throughout the preceding paragraphs, generational change comes with a break in practices rather than with cyclical practices stabilised by the use of a particular medium of representation.

5 Representing normal operations

As stated before, the central problem of coordination faced by centres of air traffic control is to adjust between centralised flight plans and the semi-autonomous actual movements of planes.¹⁶ To carry out this task, air traffic control draws on two distinct sets of representation. Its contribution to the production of air safety needs to be portrayed as a performance: flight control centres actively mediate between the order of plans and the order of observed events. Far-spread activities are brought together, observed and coordinated. This performance would not be that noteworthy if air safety was produced according to a superior harmonious "logic of operation". However,

¹⁶ Although the introduction of TCAS, a cockpit-based "Traffic Alert and Collision Avoidance System", has by-passed air traffic control, it seems to have further amplified this problem (cf. Weyer 2006, 2007: 76ff.).

according to research on the large technical system of air transport, this assumption is erroneous. It seems to be more appropriate to think of air safety in terms of heterogeneous visions. Competing models of what is considered to be the perfect order have come to overlap (Gras 1993). Adherents to different models can be identified by the way they conceive of and handle critical situations. On the one hand, one has to mention the model named after "Ikarus" (Gras et al. 1994). Claiming that the capacity for adaptation and quick reaction by pilots is crucial to air safety, its basic principle is to protect the autonomy of pilots. On the other hand, this model sharply contrasts with a second one called "mechanical bird". To opt for the "mechanical bird" is to subscribe to the idea that there would be no risk of collision if control was entirely delegated to ground-based planning and engineering (*ibid.*). As indicated (and despite the fact that the titles chosen may sound a little outdated), both models are internally consistent in cognitive, in normative, and in social terms. Both models need to be permanently balanced, and this is precisely the task left to air traffic control (*ibid.*). To state it more dramatically, air traffic is in charge of the necessary linkages between the sky and the earth. Gras and his colleagues have concluded that the heterogeneous character of air transportation must be taken seriously, whenever new technology is introduced. In line with this argument, the present contribution systemically explored the coexistence of different media of representation and their implications for critical situations.

How to explain high levels of reliability while taking into account a multiplicity of different media? Following a theoretical exposition, the analysis took two steps, drawing on ethnographic material. First, I documented a failed attempt to demonstrate the advantages of digital strips over paper strips. Second, I presented a number of observations on practices that have co-evolved

with the use of the paper strip. The first part of the analysis facilitated taking the second beyond the conventions of Workplace Studies. Having placed the paper strip in its organisational contexts in the first place, the analysis could be extended to practices of larger scale and scope. Thereby, I have escaped the scheme opposing "microsociality" and "macrosociality".¹⁷ I have captured and characterised a maximum variety of practices all of which are related to different types of critical situations. Current initiatives to replace paper strips should be aware of their contribution to stabilise critical situations by closing the loop of cyclical practices. Each cycle of practices has a critical point of transition. This has been particularly obvious in the case named "rite of passage". In this regard, I have pointed out that (older) controllers tend to shy away from medial representations provided by radar screens. As described above, they repeatedly stage the mediality of this particular medium. Deliberately switching off monitors, they point to a potential for disruption and recall the difference between first and second order failures. This useful exercise in comparing dis/advantages of different media can no longer be reproduced once paper strips have become replaced by digital strips.

The observations presented in this article do not provide evidence that paper strips are "irreplaceable". On the other hand, the analyses presented above do not support the following view. According to Digistrip proponents, paper and paperless control are

¹⁷ Ethnographic studies on "situated action" tend to subscribe a microscopic research program. As examined by Conein and Jacopin (1994: 477), they often share two explanatory goals. On the one hand, they try to demonstrate that interaction with objects cannot be decontextualised, that is divorced from social interaction. Contrary to this, they seek to show that each form of knowledge or capacity is based on the use of resources which are part of its particular local environment.

no longer exclusive alternatives for technological development. The once declared objective of substituting the paper strip is said to have been re-defined. In the meantime, all major centres for research and development have adopted a new objective and a new rhetoric, which stresses "integration" instead of "substitution". As the potentials of "integration" are constantly being emphasised, paper strips have lost part of their backward reputation. Even positive qualities - such as being palpable, durable and adaptable to extremely different situations - have been attributed to paper strips (Pavet et al. 2006: 55). However, while paper strips have undeniably been rehabilitated, all the qualities rediscovered relate to the smallest cycle of practices. What then about the remaining cycles of practices reproduced and stabilised with the help of paper strips? Controllers and engineers interviewed during the case study emphasise a "longue durée" perspective. Unremittingly, they give priority to observations, which refer to more extended cycles of practice. As stated earlier, they regard the Karlsruhe regional centre as a relict of a failed attempt to harmonise air traffic control on a European scale; a relict, which was then turned into a regional advantage. Given these macro-political framework conditions, there is no neutral space, which would allow for a purely technical simulation, comparing paper strips and other technical devices. The more this macro-political aspect is emphasised, the more unlikely it will be to find an easy path towards increased interoperability.

Based on ethnographic fieldwork and interviews in air traffic control centres, the present analysis has drawn attention to multiple sets of practices, which differ in scale and scope. However, it does not provide an answer to the fundamental questions emerging in the course of this inquiry: How do different sets of practices relate to each other? How to conceive of their relationship? For instance, how to bring

together the two perspectives sketched in the previous paragraphs, stressing either short or long cycles? To deliberately leave this question open is to insist on the need for respecting differences between practices which have co-evolved with the uses of paper strips. Knowing more about the multidimensional uses of paper strips (cf. Vongmany 1998: 67) does not offer immediate practical advice. But still, there is a suggestion addressing practitioners inasmuch as that the present analysis presupposes and nourishes processes of organisational learning. In this sense, it shares the ambitions of the approach on highly reliable organisations (Hale et al. 1997, Bourrier 2002). As it is unlikely that organisations will learn from large crises and dramatic accidents, social studies of technology and risk should continue to invest in research on normal operations.

6 References

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Balancing Requirements of Decision and Action: Decision-Making and Implementation in Free/Open Source Software Projects*

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received 30 June 2006, received in revised form 16 June 2008, accepted 26 June 2008

Abstract

This article deals with decision-making processes about new development aims in Free/Open Source software (FOSS) projects. It focuses on the question how community driven projects manage to not only make decisions but also implement them successfully. Following the approach of Nils Brunsson, the requirements of (rational) decision-making and action are somewhat antagonistic: On the one hand, rationality of decision-making implies extensive evaluation of alternatives and arguments that can lead to an uncertainty as to which of the alternative will be chosen. On the other hand, a good basis for collective action is established when uncertainty is reduced and consistent expectations exist as to what kind of action will be performed. Corroborating on an empirical analysis of a decision-making process and interviews conducted with FOSS developers, three mechanisms of ending a discussion are identified. The paper concludes evaluating to what extent each of these mechanisms serves the requirements for decision-making and action.

* The research for this paper has been carried out in a PhD project within the Research Training Group 'Genese, Strukturen und Folgen von Wissenschaft und Technik' at the 'Institute of Science and Technology Studies' (Bielefeld University). The paper is largely indebted to the discussion of an earlier version of the paper in the 'Methodenwerkstatt' held by Alfons Bora and to Alfons Bora's advice. I would like to thank the DFG for supporting the PhD-project with a doctoral grant and I would also like to thank two anonymous referees of STI-Studies for their helpful and instructive comments. Without the help of Felicitas Krämer and Marc Weingart I would not have been able to write this article.

1 Introduction

The field of Free/Open Source Software (FOSS) development has become a field of interest for the disciplines concerned with technological development and innovation activities. Although the phenomenon is still quite new there are a variety of aspects that have already been studied in detail. In this paper I will focus on a particular aspect of FOSS development. I will deal with the question, how a certain type of FOSS project – so called community driven projects – manage to decide about their aims and to implement these decisions. In these projects, developers mainly participate on a voluntary basis, and most projects display a low degree of role differentiation and a weak hierarchy. Thus, it is neither self-evident nor trivial that these projects manage these tasks. But the existence of FOSS shows that there must be a solution to the decision-making and implementation problems. This observation serves as a starting point. By analyzing a decision-making process I will show that community driven FOSS projects are not only orientated to decision rationality but also have to consider how to implement the decisions through collective action. However, the analysis undertaken in this paper has a limited scope in two respects. Firstly, it deals with decision-making and implementation only with respect to a certain type of community driven FOSS projects. In other kinds of FOSS projects different mechanisms may exist. Secondly, the paper has an explorative nature. It analyzes decision-making in FOSS projects on an empirical ground, but is far from providing final evidence that there are not more mechanisms or even that the mechanisms analyzed here are the most important ones.

The paper is organized as follows: In providing an overview of the literature of the FOSS development, I will highlight some main characteristics of FOSS projects that are important for the question of collective action. Sub-

sequently, a theoretical framework is developed that allows to differentiate between decision-making on the one hand, and actions to implement these decisions on the other hand. In the fourth section the methodology of the analysis is outlined and the case of a community driven project is introduced. The fifth section deals with a decision-making process and its implementation. The various factors that influence this process are analyzed and enriched with findings derived from interviews with FOSS developers. In the conclusion the results will be summarized, and it will be evaluated how well different outcomes of decision-making processes meet the requirements of rational decision-making and action.

2 FOSS: Main characteristics¹

The distinction between Free/Open Source Software and other types of Software is based on different types of licenses by which the use of the software is regulated (Stallman 2002: 41). FOSS is protected through a special license permitting everyone unrestricted use, copying, distribution, and modification. Other software licenses that do not grant these four rights to everyone make software proprietary.² The first, most important and widely used license³ guaranteeing permissive

¹ We can only refer to a selected body of research on Free/Open Source Software development here. For a very good overview of the current state of the discussion cf. von Krogh/von Hippel (2006: 976-982) for management science and Holtgrewe/Brand (2007: 28-30) for the social sciences more generally.

² There are of course various proprietary software licenses for different purposes. For the argumentation developed here, the rough distinction between free and non-free software is sufficient. For a category of free and non-free software see the website of the GNU-project: (<http://www.gnu.org/philosophy/categories.html>, last access 03/2008).

³ Lerner and Tirole 2002a; Bonaccorsi/Rossi 2003a: 9, 2003b: 1248. O'Mahony (2003) argue that FOSS licenses

application of software is the GNU General Public License (GNU GPL).⁴ In contrast to some of the FOSS licenses,⁵ it specifies one important restriction: the terms of the license have to be applied to any modified or non-modified version of the program. As a consequence, permissive application of the program and its derivatives is guaranteed in the future. This 'repetition clause' makes a program 'copyleft' and prevents FOSS from being changed into proprietary software.⁶ The consequence of the license is that FOSS becomes a privately produced public good (O'Mahony 2003: 1180) without rivalry in consumption.⁷

FOSS can be developed in various ways. It is not uncommon that a FOSS program is developed by an individual programmer,⁸ produced behind closed

are an integral part of a more complex system of regulations that include legal and normative sanctions, incorporation of the project, individual copyright transfer and a protection of trademark brands.

⁴ The GNU project was the first to develop free software. For the history of the project, see Stallman (2002: 15-30; 1999). The aim of the GNU GPL is to protect the work of the project and prevent FOSS from being turned into proprietary software. For the original terms of the license see: (<http://www.gnu.org/licenses/gpl.html>, last access 04/2008).

⁵ An example for this type is the BSD License that, like all other free software licenses, allows free use, copy, distribution and modification. For the original terms of the license, see: (<http://www.opensource.org/licenses/bsd-license.php>, last access 06/2006).

⁶ The GNU GPL also has an 'infective character'. If some code protected by the GNU GPL is used in a larger work the license enforces that the GNU GPL is applied for the whole program (see Holtgrewe/Werle 2001: 54).

⁷ For this reason, the frequently used term 'almende' (e.g. Grassmuck 2002) is somewhat misleading. An important characteristic of the almende is that there is rivalry of consumption. This characteristic leads to an overexploitation of the resource and a 'tragedy of the commons' (Hardin 1968).

⁸ Ghosh/Robles/Glott (2002: 19) found out that the vast majority of the FOSS projects is carried out by one or two developers.

doors of a firm (and released) and distributed as FOSS after completion, or is produced in projects in which individual developers cooperate with firms.⁹ But there is also a unique social structure that can only be found in the field of FOSS: The original and still very important – in terms of numbers of software projects – type is 'community founded' and predominantly 'community driven'. In this type of project, the social structure in terms like e.g. the pattern of decision-making and the coordination of programming activities arises by self-organisation. This structure first appeared in 1991 in the Linux project, developing a free operating system for different hardware platforms.¹⁰ This kind of social structure has a special feature: It is often highlighted that the absence of any technical restrictions and free access to the project infrastructure enables anyone who is interested to participate. In principle, each participant can pose questions, suggest new aims of the project, monitor and participate in decision-making processes, and even contribute to the code of the program.

One important focus of research on FOSS projects concerns the motivation of the participants. It was Lerner and Tirole (2000, 2002b) who asked, taking a rational-choice perspective, why people should contribute to the production of a common good if no one can be excluded from its use even when not having contributed to the production of the good. Lerner and Tirole argue that there are various factors guiding developers to participate in FOSS projects. They suggest to distinguish between immediate benefits like payment, fixing a bug, or customizing the program to one's own needs

⁹ Like RedHat, SUSE and Mandriva Conectiva for example.

¹⁰ Eric Raymond highlights the relevance of the innovation of open software projects in his influential essay '*The Cathedral and the Bazaar*' (1999: 27-78). For a sociological analysis of this organisational innovation and the consequences for the development of FOSS see Taubert 2006: 72-87.

on the one hand and delayed benefits and rewards on the other. To the latter count ego gratification incentives (peer recognition) and career concern incentives that may lead to future monetary rewards (Lerner/Tirole 2002b: 213 f.).

In contrast to these early explanations of participations in FOSS development, other scholars highlight that – especially in the case of community driven projects – the intrinsic interest in developing software itself is one important incentive (cf. Osterloh/Rota/Kuster 2002; Hertel/Niedner/Herrmann 2003; Lakhani/Wolf 2005; Taubert 2006). Others claim that it is even the most important factor (Brand/Holtgrewe 2004: 17) that leads to contributions in FOSS projects. Furthermore, surveys with FOSS developers show that they feel highly creative while tackling development problems, and they frequently or always lose track of time (Lakhani/Wolf 2005).

A critique of the earlier rational-choice explanation of Lerner and Tirole concerns the assumption that a situation of choices precedes the contributions. It is suggested to differentiate between the first contribution and enduring engagement in FOSS projects. Exhaustive consideration of costs and benefits are more likely to occur in the first than in the second case (Taubert 2006: 141). Other studies show that the motives for a first participation differ from the motives of a long-term participation (Shah 2006: 1004), and that the relevance of intrinsic motivations increases in long-term participation. Moreover, it is supposable that the relevance of different factors varies with the type of the project. In the case of community driven projects it seems plausible to assume that monetary payment plays a less important role than in projects where software companies contribute.

Another research focus on FOSS projects concerns the way the development process is organized. A common observation is that the degree of involvement varies to a large extent and

that the group of highly involved developers is relatively small. For example Koch and Schneider (2002) found out that the majority of the 301 developers identified contribute a small amount to the code¹¹ while the 15 most active developers contribute 48% of the lines of the code (Koch/Schneider 2002: 30). Those findings suggest that these highly active developers also make the decisions. Thus, the group of decision makers is relatively small. Although no one in particular is the owner of a certain program, a certain role structure seems to exist. In the literature it is very common to distinguish between the maintainer, the core-developer and the community of users (Grassmuck 2002: 237-239). The different groups of participants not only vary with respect to the degree of activity, but also with regard to their contributions. For instance, *users* report bugs and sometimes also suggest solutions. *Co-developers* participate in these activities but also analyze and contribute to the code. *Core-developers* and the *maintainer*, however, contribute to the already mentioned activities, but are additionally involved in decision-making processes (Gläser 2006: 270).

But even if the number of participants involved in decision-making is small, how are decisions made in FOSS projects? Some authors highlight the role of 'leadership' or 'leadership-teams' and the moral authority of the maintainer (e.g. Lerner/Tirole 2001: 823). This is indeed true for some of the prominent projects of high strategic importance, such as Linux and Apache (Lerner/Tirole 2002b). But there are also big projects in which the degree of formalization of the organization is low.¹² In these projects the question of how the participants manage to decide

¹¹ In terms of lines of the code.

¹² An example for this type of project is the K Desktop Environment (KDE) that develops a graphic user interface for Unix- and Linux Operation Systems (See Holtgrewe/Brand 2007: 36).

about and pursue their aims without having recourse to a hierarchical modus of decision-making seems to remain open. In the next section, a theoretical framework is developed, which is adequate to explain for decision-making processes in the case of FOSS projects.

3 Theoretical Framework

In sociology and management science a large body of literature about decision-making exists. An overview of the most important concepts could start with the rationalistic tradition rooted in theory of bureaucratisation by Max Weber (1972). It postulates that organizations are rational actors that make decisions on the principles of impersonal application of rules, records and control. Important contributions that should be mentioned are the critique of the assumption of rationality of decision-making in Cyert/March (1963) and March (1994), and the garbage can model of decision-making where decision rationality seems to be lost (Cohen/March/Olson 1972). It is not the place here to unfold such an overview. One thing I wish to highlight by mentioning the work of these eminent scholars of the field is the focus of these theories of decision-making. The focus is very much on the 'logic of the choice' of alternatives and far less concerned with processes of the implementation of the decisions.¹³

A more adequate theory about decision-making in FOSS projects should offer a broader perspective. The aim of FOSS projects is not to make decisions but to develop software. Therefore, making a choice is not an end in itself but a step towards the implementation of a decision. A scholar in the field of organisational studies, who offers a theoretical framework that allows the integration of both aspects, is Nils Brunsson. In the first of his main

works, 'The Irrational Organization' (1985), he starts with an overview of the main components of classical management theory and its normative decision-making theory. The picture drawn there suggests that managers mainly deal with decision-making and ample suggestions are made as to how the rationality of decision-making can be improved. In this context 'rationality' means that managers make decisions on the ground of stable preferences, careful consideration of all alternatives regarding the costs and benefits and the likeliness that these costs will occur and the benefits will be realized.¹⁴

From this starting point Brunsson comes to the common observation that decision-making in real life organizations frequently violates the rules of rationality. He does not intend to explain the differences between the normative standards of rational decision-making and empirical decision-making processes in a 'chauvinist' manner. Examples for those explanations would be that "subjects are not clever enough to behave rationally"¹⁵ (Brunsson 1985: 17), that there are "certain types of irrationality" "inherent in the human character" (ibid.) or that there are "practical constraints" (ibid.). Brunsson, however, does not argue that these explanations are fundamentally wrong. Instead, he formulates a critique on the way the topic 'decision-making' is usually framed: „A decision making perspective fails to recognize that managers do more than make decisions. Making a decision is merely a step toward action. The decision is not the end product. Managers get things

¹⁴ In this field the rational-choice paradigm is very prominent. For an overview see Elster (1986).

¹⁵ This kind of assumption can also be found in the concept of 'bounded rationality'. In this concept it is argued that, compared to the complexity of the world, the capacity of the human mind for formulating and solving problems is low (Simon 1957: 198; March/Simon 1958, March 1978).

¹³ This observation has been made by Brunsson (1985): aside from his contribution the situation did not change much.

done – act and induce others to act.” (ibid. 18) Therefore, Brunsson suggests extending the perspective from the narrow focus on decision-making to a broader perspective: on decision-making and its implementation in organisational action.¹⁶ With this change of the perspective a good deal of deviation from ‘rationality’ can be explained through the demands of ‘action’. To put it differently, many aspects of decision-making that seem to be irrational from a decision-making perspective can be regarded as rational from the action point of view, if they improve the conditions for collective action.

What are the requirements of action? And what aspects does a decision maker have to take into account in order to prompt action? Brunsson points out that, for organisational action, different actors have to cooperate, and that a common cognitive, motivational, and commitment-related ground has to be reached. First, in the cognitive dimension it is important that there are consistent expectations about future action. Members of the organisation find it worthwhile to act only if they believe that “their doing will result in an organizational action” (Brunsson 1985: 19). If the individuals are not sure whether or not an organisational action is going to take place, they will not find it worthwhile to act. The second condition for organisational action is motivation. In this concept, ‘motivation’ means that people desire to contribute to the organisational action with their individual action. They will merely contribute if they regard the aim of the organisational action as a good thing (ibid. 19).

¹⁶ Brunsson’s theory only deals with a specific type of action: organisational action for change. Action means any activity that is not purely cognitive in character, organisational action means that action is „accomplished by several organization members in collaboration“ (Brunsson 1985: 6), and action for change means „that a new kind of organizational action is undertaken, or that a previous type of action is discontinued, or both“ (ibid. 9).

The social aspect of action is commitment. This third condition for organisational action can be described by the fact that the members of the organisation trust on a certain type of behaviour, or attitude, which is shared by the rest of the organisational members involved in the action. If they do not trust in the existence of this attitude, or behaviour, they are not willing to take part in the action (ibid. 20). At this point of Brunsson’s argumentation it appears to be clear that a certain behaviour, which leads to an improvement of decision rationality (e.g. taking more alternatives into account, analysing the consequences of an action in greater detail and so on), does not necessarily improve the conditions for organisational action.

In community driven FOSS projects the requirements of actions deserve closer attention because of specific framework conditions under which decision-making and the implementation of decisions takes place. Like other organisations solely relying on voluntary (unpaid) work, the projects themselves usually do not have financial resources that could be used for motivational purposes. This feature has an effect on the creation of the conditions for action: Since a lack of agreement cannot be compensated by financial means, the motivation to participate in collective action depends to a large degree on considering the chosen action as a ‘good thing’. Therefore, one can expect that the agreement on a specific aim be of higher relevance in the case of community driven projects than in organisations, which can offer other resources for the motivation of the members.

In order to better understand the requirements of action, Brunsson gives a variety of practical examples of techniques for the improvement of the conditions for collective action. The main scope of these techniques is to reduce uncertainty, since uncertainty obstructs the cognitive, motivational and commitment-related conditions for action. Here, I will stress only two of

them. A first technique or strategy is to limit the numbers of alternatives taken into account. This helps to reduce the degree of uncertainty and makes it more likely that a given action is going to take place. A typical way to limit the alternatives is to propose alternatives that are clearly unacceptable, in order to highlight the advantages of the one (and only) acceptable alternative (ibid. 23). From a decision point of view this behaviour is irrational. But from an action point of view this strategy is rational: in the motivational dimension this strategy clarifies which alternative is desirable and in the cognitive dimension it helps to elucidate the expectations about which option will be chosen, and what kind of organisational action will be performed.

Brunsson describes a similar technique, which concerns the assessment of consequences. The rational calculation of the likeliness of positive and negative outcomes and the exhaustive assessment of the consequences is highly rational from a decision-making point of view. But as far as it creates uncertainty, it is highly irrational from an action point of view. A technique to avoid uncertainty is to reduce the rationality of decision-making by looking at the consequences in one direction only, by assessing desirable consequences for the acceptable alternative, and by suppressing any negative consequences it might have (ibid. 28). This strategy aims to improve the conditions for action at least in the motivational dimension.

But these conditions also depend on the outcome of collective decision-making. It makes a difference if the process of decision-making is concluded through consensual agreement, compromise or disagreement.

- The most 'harmonic' outcome of a decision-making is consensus. All actors involved in the decision-making process are convinced that the chosen alternative is the appropriate one, and there is no antagonism within the participants of the

project. The absence of antagonism is not necessarily the result of a rational and extensive discourse, but can emerge in different ways. For example, it can arise in situations where only a few alternatives are taken into consideration and it is obvious which one is preferable.

- Compromise is a distinct outcome of a decision-making process. Although all actors accept the outcome, the compromise is in no accordance with the interest and preferences of at least one actor. Actors usually agree to a compromise after bargaining on the ground of the insight that it is the best result that can be reached if the diversity of perspectives, interests, and preferences of the other actors involved are taken into account.
- A third outcome is dissent. Here, neither consensus nor compromise can be reached in a decision-making process, and the antagonism still persists. In the case of FOSS-projects, and with respect to the action dimension, different situations can arise: (a) the development process stagnates, (b) the project splits up in different sub-projects (forking), or (c) an alternative is enforced by an actor, (and is accepted by the others).

Before starting to analyze a decision-making process in a community driven FOSS-project – and before considering the question of how the specific decision outcomes and routines serve the requirements of decision-making and action – the methodology on which the data collection is based will be outlined.

4 Methodology

The following analysis is based on a case study of a project that serves as a typical example of a community driven project. The project was selected because it met the following criteria:

- *Size of the project:* The number of developers involved in FOSS projects vary on a large scale between the many one- or two-person-projects and the few big (and mostly very famous) projects where some hundred developers are involved. Therefore, it was ensured that the selected case would be big enough that problems of coordination would most probably appear. The big and famous projects were excluded because they represent extreme cases, with partly exceptional social structures and coordination routines.
- *Duration of the project/success:* To find a case where established solutions or mechanisms for coordination and decision-making can be observed, a project was selected that has already released a stable version¹⁷ of the program
- *Mailing list with an archive:* This criterion was set up for practical reason. It was formulated to guarantee easy access to the earlier communication of the project.
- *Type of the program:* Due to an interest in the influence of users for the development of software in the study, (although this is not the main focus here) a project was selected that develops a program, which addresses users who do not have to have competencies in programming. On account of this criterion all projects developing programming tools were excluded.

One project that meets these criteria is 'KMail', which develops an email client

for the desktop environment 'KDE'. It includes functions such as sending/receiving emails, tools for writing emails (editor and spell checker), an address book, and the integration of PGP encryption. From a user perspective, it resembles other email clients such as Microsoft Outlook or Mozilla/Netscape Mail & Newsgroup. Since the foundation of the project in 1997, 48 project members have worked intensively on the project and made substantial contributions to the program. As a result, they are listed as 'authors' on the project's website.¹⁸ *Prima facie* and with respect to the number of developers involved, the project seems to be a large one. However, this impression needs to be put into perspective by considering the high level of fluctuation: Most developers join the project, work on a part of it for a while, and then leave after the work on this specific part is done. Only the project's maintainer and the core developer remain involved for longer periods. In the case of KMail, usually less than ten (core-) developers work on the project simultaneously.

The KMail project is based on an advanced technological infrastructure. Its website provides information about the program, its features, and its authors;¹⁹ a bug-track system for collecting user feedback on the program's unexpected behavior;²⁰ a download site where one can obtain the latest versions of the program; and a current version repository (CVS) for the management of the development version of the source code on which the members of the project are working. Communication concerning the development of the program takes place between the programmers on a mailing list. This list is

¹⁷ A feature of FOSS is that new versions of the program are published rapidly. The projects distinguish between developer versions or unstable versions on the one hand (that are used by developers in order to remove bugs and make the program more reliable), and official releases on the other hand (that are well proven and that are intended to be used by users, who do not have any special technical competency in programming for their normal day-by-day use).

¹⁸ See: (<http://kontakt.kde.org/kmail/authors.php>, last access 03/2008).

¹⁹ See: (<http://kontakt.kde.org/kmail/>, last access 03/2008)

²⁰ KMail shares a bugtracking system with the master project KDE of which KMail is part of. See: (<http://bugs.kde.org/>, last access 02/2008)

the 'location' of the project where collective decision-making takes place.²¹ A notable point about the mailing list is that everybody who is interested may not only follow the discussion, but can also send an email to the list and become actively involved.

The research design is based on two types of material. The communication on the mailing list is one type of material: it was analyzed for a period of twelve months. Furthermore, twelve interviews with FOSS-programmers who participated in different community driven project were conducted, transliterated and analyzed.²² These types of material are complementary:²³ The communication on the mailing list offers an access to the public communication of the project. Here, the discussion on decision-making with its rituals and routines can be observed. The interviews were conducted with an interview guideline. They give insights in the interpretations, beliefs and normative orientations of the developers that form a common background which is not made explicit in the discussions of the developers on the mailing list.

²¹ This list can be found at: (<http://lists.kde.org/?l=kmail-devel>, last access 3/2008). In the course of the integration of KMail and other programs like KOrganizer, KAddressbook, and KAlarm into a 'personal information management package' the projects now share a developer mailing list. For further information see: (<https://mail.kde.org/mailman/listinfo/kde-pim>, last access 03/2008). The integration took place after this study had been accomplished.

²² The communication on the KMail mailing list was observed and analyzed between 01/2001 and 12/2001. For a more detailed description of the methodology see Taubert (2006: 120-123). Two of the interviewees came from the KMail project, the other 10 developers were involved in different community driven FOSS projects. This design was chosen to compare the conclusions drawn from the KMail project with other projects for validation.

²³ See the methodical remarks in Hofmann 1999: 198.

The communication on the mailing list and the interviews were analyzed by applying qualitative-hermeneutic interpretations.²⁴ Three aspects of the interpretation of the material should be highlighted here. First, the chronological appearance of the communication was taken into account, following the aim to find different interpretations, and to exclude one after another in the progress of interpretation whenever inconsistency occurs. This implicates that the material was interpreted in the context of its appearance. Second, much attention was concentrated on the beginning of episodes on the mailing list,²⁵ since the starting sequence sets the scene for the further course of the discussion.²⁶ Third, it was proven systematically whether there was any empirical evidence that conflicted with the interpretation of the material.²⁷

5 Decision-making and its implementation in a community driven FOSS project

The framework conditions of community driven FOSS projects raise the question how the participants manage to achieve an aim successfully. Following the perspective of Brunsson, it becomes clear that this question is two-fold: On the one hand, one has to ask how decisions are made, and on the other hand, it has to be analyzed how (good) conditions for collective action are created. I will answer these two questions by taking a closer look at a

²⁴ The interpretations were presented and discussed in great detail in a seminar on qualitative methods with around 10 other researchers from different disciplines including sociologists. My thanks go to the participants of this seminar.

²⁵ The beginning of a new episode is often (but not always) marked by a new subject-line in the emails on the mailing list.

²⁶ The first two aspects were borrowed from sequence analysis (Oevermann 1990: 10).

²⁷ This step of the analysis was inspired by grounded theory methods (Strauss/Corbin 1990: 108-109).

decision-making process on the mailing list of the KMail project. A case that provides a good starting point for the empirical analysis is a suggestion concerning the graphical user interface (GUI), that is, the graphical appearance of the program on the screen that a user would call 'the program'.

5.1 Argumentation and Bargaining

This discussion starts²⁸ with the following email by a developer who had not contributed to the project thitherto, but gained a high reputation for his work in the KDE project, of which KMail is part:

„Hi all, ok, I have some small but important things that we (KD 7, KD 8 and I) discussed out that we need for kmail and which I like to do and need the others approval. Sorry that KD 8 changed things this week without asking and even I didn't see what was g Balancing Requirements of Decision and Action oing on.“ (KD 6, 2001-05-30 10:31:09)

The way in which the developer KD 6 addresses a new aim on the KMail mailing list is a bit untypical. The standard procedure is to post an email on the mailing list, and then to discuss it there, instead of announcing it as something that has already been discussed with other developers somewhere else. With the suggestion of a new aim, a decision-making situation arises and it is shaped as a selection between two alternatives: the project has to decide whether or not it is going to implement the aim.

The reference to the other developers who have already agreed on the suggestion and who began with the implementation of the feature points to the action dimension of the decision-making process. The activity of the developers indicates to the other participants that there are developers with a commitment to the suggested aim.

The fact that the developer posts an email on the list in which he asks for the approval of the others, his apologies for the action that has already been undertaken by one developer and the explanation he gives (instead of implementing the desired functionality directly) points to a first rule that has to be followed in decision-making processes in this project: aims have to be discussed first so that other developers have the opportunity to influence the decision-making process and the development-path that is followed by the project.

„Now, what do we need and why do we need it?

What we need:

the default setting should be a long folder list

why: because it's the common look of mail clients and other applications having a slit view.“ (KD 6; 2001-05-30 10:31:09)

The suggested aim is introduced rhetorically with a two-part question: one referring to the subject of the suggested development aim ('what'), and the other referring to the reason for this ('why'). The rhetorical structure of the email reflects an important aspect of the decision-making process. The normal mode for reaching a decision in this project is argumentation, that is, to convince other developers by virtue of one's arguments. From the theoretical perspective developed above, the obligation to give reasons and to discuss the aim is a norm that improves decision rationality. It allows other members of the project to participate in the discussion and to bring in other arguments, so that the argumentative basis of the decision is broadened.

The first suggestion for the new look of the GUI concerns the standard setting of the folder view on the left side of the screen: The setting can be changed by users if other settings will meet their needs in a better way. The change of the appearance is justified as an adjustment of the program to fit the look

²⁸ The beginning of the discussion is marked by a new subject line.

of other email clients. In the following, we shall jump to the third suggestion in order to avoid redundancy in our analysis:

„c) more columns in the folder view and the mail view for various purposes

which ones: a column in the folder view for the unread mails and one for the total mails, just like knode.²⁹

why: this is pretty standard and has proved to be efficient towards the user looking at the folder view, also makes the clients look more consistent.

Another one in the listbox of the mails to sort threaded/unthreaded. I know that can be done via the menu or the configuration but even I had to look very hard for that feature to find it.“ (KD 6; 2001-05-30 10:31:09)

The suggestion shows the same structure as the one analyzed above. But, this time, the argument is explained in greater detail. The reference to another program exemplifies that, again, the idea for the suggestion derives from it. But mentioning the other program means more than just indicating the source of the idea for the suggestion of KD 6. Imitating the look-and-feel of other widespread and approved programs is regarded as a way to guarantee an efficient use of KMail: KD 6 connects the suggestion with an evaluation criterion, which legitimates the developmental aim, and an explanation of how the suggested aim improves the program with respect to the evaluation criterion. In other words, the aim is contextualized within a complex interpretation.³⁰ In the follow-

ing this criterion will be named as ‘efficiency of use’ in short.

The developer closes his email as follows:

„We would like to have these little changes done for 2.2 and would like to do them with you guys together as we think these are needed GUI improvements that would make kmail look *a lot* better and make it much easier for beginners to handle it. Please feel free to comment and blame me if something goes wrong if you’re also up with these ideas.“ (KD 6; 2001-05-30 10:31:09)

The concluding remarks give an outlook on the time schedule for implementing these features. The Code 2.2 indicates the next major release of the KDE project.³¹ Referring to the date and to the developers who are ready to implement the changes, the author of the email moves from the requirements of the decision-making process (the argumentation for and justification of an aim) to the requirements of action. By describing a concrete point in time where he and his co-workers are planning to have these new aims implemented, he reduces uncertainty as he evokes the expectation that action towards the aim will be undertaken.

For the purpose of my analysis it is interesting to notice that developer KD 6 explicitly invites other project members to discuss his aims. This invitation shows that he strives toward an agreement with other developers. Furthermore, he tries to avoid unnecessary work when announcing the plan, by asking whether anybody else is already working on the implementation of these (or similar) changes.

²⁹ Newsreader for the KDE desktop, See also the website of the project: (<http://kontakt.kde.org/knode/>, last access 04/2008).

³⁰ See also Holtgrewe and Brand (2007). This study applies Boltanski’s and Thévenot’s concept of ‘polity order’ to explain how new aims in FOSS projects are legitimated.

³¹ The date of release was August the 15th 2001. The version was introduced as an ‘easy-to-use Internet-enabled desktop for Linux and other UNIXes’. See: (<http://www.kde.org/announcements/announce-2.2.php>, last access 04/2008).

The email interpreted above triggered different responses on the KMail mailings list. Moreover, it marks the starting point for a detailed discussion of the aims. Its intensity can be explained by two reasons: First, the graphical appearance of a program is an attribute of high importance as this part of the program is literally in front of every user's face. Therefore, it can be assumed that most, if not all, developers involved have a preference concerning the GUI. Second, the developer KD 6 has signaled strong commitment to the aim, and the other participants in the project have to expect that the group of the three developers will strive towards action as soon as the discussion is closed and a decision is made.

Some responses in the following discussion are questions concerning the aim leading to further explanations. However, some of the subsequent emails show disagreement. Especially suggestion 'c', the implementation of more columns, leads to controversy. One developer comments on it as follows:

„I think you should be able to turn that off, though. I don't think it's possible with the kmail version from kde-2.1.1 to delete columns but I think that would really be a good idea. You could then add as much columns as you want without doing something wrong. You'd have to talk about the default setting though.“ (KD 9; 2001-05-30 10:49:42)

The developer KD 9 picks up the idea about the graphical appearance of the program but makes an alternative suggestion. Thus, from a decision point of view the decision-making process is becoming more complex and the decision rationality is improved: KD 9 does not only bring a third alternative into play (aside from leaving the GUI as it is and the original suggestion of developer KD 6), but also introduces another evaluation criterion. While KD 6 argues for 'efficiency of use' KD 9 high-

lights the relevance of 'adaptability' of the program for different user's needs.

From an action-rationality perspective the posting from KD 9 tends to obstruct the basis for action, as it increases the level of uncertainty. He signals commitment to his own suggestion so that it is becoming less likely that the original suggestion from KD 6 will be implemented. Besides this, the introduction of a different evaluation criterion also affects the motivational basis for action: On the one hand, the original suggestion of KD 6 cannot be regarded as a good thing, if one applies the evaluation criterion 'adaptability'. On the other hand, the suggestion of KD 9 is not desirable if one has the 'efficiency of use'-criterion in mind. Now, since the likeliness of action is reduced, it is not very surprising to see that KD 6 is unhappy with the emergence of an alternative. He argues for his initial suggestion:

„Hmm... I think changing the default by itself without making that configurable does make the most sense. Please have a look at knode for what I mean (nsmail and outlook express do the same as pretty every mail client around) [...]

What I want is to have it look like this:

column1: Foldername column 2:
number of unread mails column 3:
number of total mails in folder.
That's the precise look :)“ (KD 6;
2001-05-30 11:35:09).

This reply makes another reference to the other program which offers the same functionality. More empirical evidence is given by KD 6 that the modification is widespread, and therefore makes KMail easier and more efficient to use. The second paragraph has a more illustrative character. A concrete picture is drawn as to how the GUI will look like, after the implementation is made. Again, it takes only a few moments until developer KD 9 replies to this email.

„I don't understand why you feel that you should take the choice of what the user wants out of his hands. That is IMO³² pretty stupid. Sure, the default is very important as most beginners don't change it but if the user KNOWS what he wants then he should be able to do it.

> column1: Foldername column2: number of unread mails
column 3: number of total mails in folder. That's the precise look :)

Now that I understand it I think it's a good idea“ (KD 9; 2001-05-30)

Like KD 6, KD 9 argues for his evaluation criterion. He emphasizes the high relevance of 'adaptability' of the program to the needs and habits of different users. At this point, it becomes clear that the antagonism is not only about different aims, but also about different evaluation criteria that KD 6 and KD 9 apply.

Whereas KD 9 rejects the initial suggestion of KD 6 in the first part of the email, it is interesting to see that the evidence and the illustrations given by KD 6 convince him to agree on one of the changes. A third suggestion arises here that can be regarded as a compromise between the two initial ones: changing the default setting of the graphical appearance (that meets the evaluation criterion 'efficiency of use'), but at the same time making columns configurable (this meets the evaluation criterion 'adaptability' of different user's needs).

After the other developers have shown that they agree with this compromise, KD 6 pipes up again and stresses the previous decision-making process:

„Ok, that³³ was probably too drastic. We can make it configurable with a checkbox like „use old Kmail user interface“ or something

>> column1: Foldername column2: number of unread mails
column 3: number of total >> mails in folder. That's the precise look :)

> Now that I understand it I think it's a good idea“

ok, then we agree on this as well“ (KD 6; 2001-05-30 14:20:55)

Triggered by the disagreement of KD 6, KD 9 completes his suggestion with a configuration option that allows users to adapt the program to their needs. It seems that a mutual understanding has been reached, a new aim has been found, and that the decision-making process has been closed.

This first step in our analysis of a decision-making process in a community driven project, points to the following features: In decision-making processes, developers are oriented toward the norms of transparency and openness. Suggestions are open for discussion, situations in which decisions have to be made are marked as such, so that the other members of the project can participate. This orientation could already be seen in the first mail that opened the discussion. The developer KD 6 had to make excuses for having immediately begun with the implementation instead of having discussed the aim on the mailing list before. But argumentation is not just a ritual: As the decision process concerning the default setting of the graphical appearance shows, developers can be convinced by virtue of an argument.

But there is a second mechanism of closing a decision-making process. The analysis shows that aims do not only have to be suggested, but also have to be justified by interplays of suggestions, evidence, evaluation criteria, and arguments. The different evaluation criteria the proponents refer to are not taken into question but function as an anchor of the justification. In cases comparable to the one analyzed above, dissent arises with reference to these criteria. Here, it is likely that the antagonism cannot be solved by rational argumentation. Finding a compromise

³² Acronym for 'in my opinion'.

³³ This refers to the initial suggestion by KD 6 to modify the GUI without implementing a configuration option.

and balancing the suggested aims and evaluation criteria on a broader bargaining level is the way to come to a decision in those cases. The discussion strives towards an absence of protest (usually uttered as 'exit' or 'voice')³⁴ then, in such a way that everyone involved accepts that his or her preferences are cut back.

In the light of Brunsson's distinction between the decision- and the action-dimension, the first step of the analysis yields the following results: The framework conditions of the project Kmail and the normative obligation for argumentation enhance decision rationality. The openness of the project and the opportunity to participate in the decision-making process foster the emergence of alternative aims and different evaluation criteria. More alternatives are compared, discussed, modified, and evaluated under different viewpoints.

From the collective action point of view, the results of the first step of the analysis look somewhat different. Two mechanisms that effectively reduce the numbers of alternatives could be identified: The first one is convincing the members of the project of the advantages of one alternative by argumentation. The second one is the search for a compromise which can be reached through bargaining. If a stable consensus is reached, the first solution of the decision problem connects the rationality of decision-making with the conditions for action well. It serves the requirements for collective action as it makes clear which alternative is desirable and for what reason. Aside from the motivational aspect, it also reduces the number of alternatives to a single one. Therefore, it permits clear expectations about the collective action that will be performed in the cognitive dimension.

But, as the analysis shows, not all dissent can be transferred into consensus

by rational argumentation. The second solution – finding a compromise – serves the conditions for action less well. A compromise has an irrational aspect from an action point of view: Why should a developer agree with the compromise if he is not convinced that the compromise meets his evaluation criterion? Can a developer trust on the other developers' commitment concerning the compromise, when he knows that the other developers are not necessarily convinced of its superiority? It can be stressed that the compromise as an outcome is a rather weak basis for collective action.

5.2 The influence of reputation

Therefore, it is likely that other mechanisms help FOSS projects to manage decision-making and implementation successfully. An element of the social structure of FOSS projects is reputation and one may wonder whether reputation bears capacity for closing decisions and coordinating action. In the literature many scholars highlighted the importance of the reputation system: Developers in a project receive recognition from peers, particularly if their contributions are of high quality and have been made over a longer period of time (Lerner/Tirole 2000; Edwards 2001; Osterloh/Rota/Kuster 2002; Taubert 2006). In the long run, highly involved participants usually attain a considerable reputation. Consequently, mature projects reveal significant differences in the amount of recognition enjoyed by their participants. The observation frequently made in other, loosely coupled or loosely integrated social structures such as scientific communities, is that reputation has some coordinating capability.³⁵ Subsequent to this observation, the question will be addressed here, whether reputation influences decision-making processes in the case

³⁴ For this distinction, see Hirschman (1970).

³⁵ In sociology of science it is often highlighted that reputation is a basic principle for social order, as it directs attention. See for example Hagstrom 1965; Luhmann 1990; Franck 2002.

of the Kmail project. If so, how does this work? To be more precise: Do developers with a reputation for being active and productive participants in the project have more influence on decision-making than those who have less or even no reputation? Again, some hints can be found in the case of the GUI.

A highly committed member who is also the maintainer of the project³⁶ pipes up some hours after the compromise has been reached. After some comments on a different theme, he becomes engaged in the decision-making process about the GUI:

“Hi, I didn’t say anything about several columns. I prefer the way it is currently. When I don’t have any unread mails, then I also don’t need an empty column for their number. [...] At least I like to have as few columns as possible to not waste space with unimportant things.” (KD 10; 2001-05-30, 18:09:49)

By stating that he has not said anything about the suggested aim, KD 10 positions himself as a relevant player in the decision-making process. This positioning is marked by the ‘hi’ which is not located at the beginning of the email but rather in the middle. He does not regard the decision-making process as being closed in this passage (and the reaction of KD 6 shows acceptance of this positioning), and it becomes apparent that KD 10’s agreement is considered to be highly relevant for any decision-making in the project.

His contribution to the discussion shows that even developers with a high reputation, and the position of a maintainer of the project, cannot reject a suggestion right away only by virtue of his reputation or his position. The fact

that he formulates a proper argumentation suggests the interpretation, that neither reputation nor high involvement in the project frees developers from the obligation to give proper reasons for their points of view. Compared with reputation, the obligation to give reasons for a viewpoint is the more fundamental principle.

In his response to this email KD 6 refers explicitly to KD 10’s role as maintainer of the project:

„Yes, well, agreed you’re the maintainer, that gives your personal preference a great influence in the behavior [of the program, N.C.T]. I agree with you that this might be true for some users, especially long-term kmail and unix users. But if you want to get windows users to use it, the default has to be different and, most important, consistent with knode which orients itself on the „standard“ user interface.“ (KD 6 2001-05-30 18:53:26)

Although the developer affirms that a maintainer is a relevant player in a decision-making process, KD 6 does not behave in a way that is different than in situations of dissent with other developers (e.g. the situation analyzed above). He takes note of the disagreement, but does not give up his suggestion as one might expect. Instead, he begins to give reasons for it again. In this email he frames his argument in a slightly different way. The imitation of the appearance of other programs makes it easier for beginners to work with KMail. Aside from the evaluation criterion ‘efficiency’, there is another one that can be named ‘market share’ or ‘market success’ of the program.

What can we learn about the influence of reputation on decision-making processes from this example? The intervention of the project’s maintainer takes place at a point in time at which the protagonist KD 6 is trying to move from decision-making to the implementation and it has the same effect the dissent between KD 6 and KD 9 had above. It increases the degree of

³⁶ For my argumentation it is not important that the developer is also the maintainer of the project. In the other cases on the KMail mailing list other developers with high reputation caused a reopening of the argumentation that already seemed to be closed.

uncertainty and obstructs the conditions for action on the cognitive, motivational and commitment-related dimension. Neither KD 10's high reputation nor his role as a maintainer lead to the rejection of the suggestion but to a rehashing of the argument, with its positive effects for decision rationality and negative effects for the conditions for action. In other words, the example suggests that in the project KMail neither reputation nor hierarchy play a decisive role in paving the way toward collective action.

But this is not the only conclusion that can be drawn from the analysis. The reopening of the decision-making process after a situation in which a compromise seemed to have been reached, suggests that the maintainer of a project is regarded as a relevant actor in respect to decision-making by other participants. He is treated as an actor with whom an agreement has to be reached.

This finding supports a common observation in the literature, namely that reputation is a precondition for influencing the decision-making process in the sense that the respective actor is included in the discussion process and that his arguments are taken into account (Brand/Holtgrewe 2004: 14; Taubert 2006. 172 ff). The more generalized hypothesis that should be investigated on empirical grounds would be: Reputation influences decision-making as the consideration of an argument depends on the extent of reputation the respective actor enjoys.

5.3 Indecisiveness of community driven FOSS projects?

So far, the initial question of how community driven projects manage to make decisions and implement them remains unanswered in cases where an agreement cannot be reached by argument and a compromise cannot be found. In those cases the development process could easily stagnate. The evidence given above suggests that, in the case of Kmail, neither hierarchy nor reputation will help in those situations.

Therefore, one could expect that controversies continue for a long time without a possibility to solve them. Therefore, one could assume that community driven FOSS projects like Kmail struggle with a certain weakness or even indecisiveness of decision-making. But, in fact, this kind of situation rarely emerges in the analyzed case, since two non-communicative elements operate silently in the background. They prevent stagnation and help break down blockades.

Therefore, I conclude the analysis of the GUI and provide some evidence for these elements from two interviews conducted in this study. One KMail developer describes the factors that prevent a project from running into blockades. When asked if dissent about aims leads to trouble and block the development, the developer answered:

„No, not in the long run. Well there would be a thread of 50 emails or so. [...] That might go on for one and a half weeks in an extreme case. It goes on and on until people are in such a snit that they get it all together and implement something. It may well be that the one or the other isn't happy with it afterwards, but you can't please all the people all the time.” (KD 1, interview)³⁷

This quotation confirms the analysis above, that there are cases of dissent, which cannot be solved by argumentation. The developer describes that participants come to a point at which they get tired of discussing the issue, break up the argumentation, and start to implement something. One can say that, in situations of enduring dissent, time helps to come to a solution as participants are aware that stubbornly insisting on one's own point of view – repeating arguments, providing more evidence and reformulating evaluation criteria – neither helps the decision-making process nor its implementation

³⁷ The interviews were originally conducted in German, the quotations in this section are translated by the author.

in collective action. I would like to suggest that such an increase of a pragmatic willingness to act should be interpreted with reference to a framework condition of the project. It seems reasonable to assume that the willingness to come to a solution is very strong in projects, where an intrinsic interest serves as an eminent motivation. In these cases stagnation deters the developers from developing software, viz. an activity they are very much interested in.

Aside from consensus and compromise, there is a third way to come to a decision that can be found in the interviews. The following passage from another KMail developer illustrates this:

“Most importantly, there is no one (in FOSS projects, N.C.T.) who really says how the work has to be done if the project can’t decide. In the extreme case, it is the one who opens the editor and writes down the patch. The one who does the work and not the one who babbles on and on.” (KD 2, interview)

This quotation gives evidence that a stagnation of the development process can occur, and that there is no decision maker who can decide top-down in a hierarchical manner. Instead, the lack of a legitimized decision maker who decides in the case of dissent is compensated by another mechanism, which is the opportunity to switch over from decision-making to action without having reached an agreement in the project. It is interesting to note that the developer describes the development activity very demonstratively and colorfully with terms such as ‘doing the work’ and ‘opening the editor’, whereas participation in the discussion is referred to in quite disrespectful terms. Contrasting these two kinds of involvement shows that practical development work is held in higher esteem than participation in the argument. But as seen in the case analyzed above, the argument is a crucial factor: It is necessary to discuss the suggestion before switching to the development

activity. Remember that the developer KD 6 had to apologize because the development activity already started without any prior discussion.³⁸

6 Conclusion

Collective decision-making and implementation in FOSS projects take place in a constellation of conflicting demands. On the one hand, a larger number of developers being involved improve the search for solutions (Kuk 2006: 1034). On the other hand, a larger number of developers complicate the process of reaching a decision. This does not only lead to an increase of communication and cooperation costs (Brooks 1975) but, with reference to Brunsson, it also increases uncertainty, and can obstruct the basis for action. In this analysis three outcomes of the decision-making and implementation problem could be identified in the case of Kmail. Therefore, in this closing section the different outcomes will be discussed in the context of the theory developed above. In addition, it will be evaluated how they match the requirements of decision-making and action.

- (a) *Rational consensus* as an outcome seems to match the requirements of decision-making and the requirements of action well. Closing the

³⁸ An often discussed result of dissent is forking a project and developing different versions in separate projects. In this case study such a dramatic change of the project structure could not be observed and it seems that forks seldom happen. There are two factors that stand against forks. First, in community driven projects splitting a project would also imply to split-up manpower. This would increase the workload for each participant, slow down the speed of the development progress and could lead to the necessity to cut down the project’s aims. Second, it is likely that incompatibilities between the different versions of the program would arise. This effect is critical in cases where software with large network effects is developed. The negative impact of those events is well known to FOSS-developers from the history of the UNIX operating system (see McKusick 1999).

decision-making process by virtue of an argument after having different suggestions discussed in-depth, leads to a well-founded decision. After a decision is made, it is clear what kind of action has to be expected on a cognitive level and for what reason the action is desirable. Those circumstances should lead to a high level of motivation among the developers. And it is also likely that the protagonists of the chosen alternative have expressed commitment to the aim during the discussion (like in the example above), so that a good basis for collective action should be created.

The only critical aspect of this solution of the decision problem is a considerable degree of uncertainty that can emerge during long-lasting discussions. I would like to suggest that this relatively high level of uncertainty, allowed in the course of a decision-making, should be understood with reference to the motives of the developers to participate in FOSS projects. As stated above, they are intrinsically interested in the development process itself and in the success of the project, and they can expect that other developers share this attitude. These framework conditions might permit a higher level of uncertainty than in other organizations where such conditions do not exist.

- (b) *Compromise* matches requirements of rational decision and action less well than rational consensus. When a compromise is introduced in the decision-making process, the developers have usually discussed the suggestions in detail. Therefore, it is unlikely that new arguments will be pushed forward and the rationality of the decision will be improved by further discussion. From the requirements of action the compromise reveals a particular irrationality: Why should a developer participate in the implementation of a certain compromise, although it is only second choice for her or him,

and not the right thing to do? If the lower degree of motivation of part of the developers is taken into account, it is supposable that he or she accept that other developers work on the implementation of the aim, but is not getting involved in the work him- or herself. In other words, a compromise is a solution for the problem of decision-making as it marks an end of a discussion that tends to become unfruitful. But it nevertheless is inclined to obstruct the motivation for *collective* action if some developers think that there are better ways to go.

- (c) *Moving from decision toward individual action* is the last solution for the problem of decision-making and its implementation in FOSS projects. The idea of collaborative work is abandoned here as it is foreseeable that only the (group of) developer(s) who regard(s) the option as the right thing will contribute to the process of the implementation. Since a basis for collective action cannot be created, individual action takes its place. From the viewpoint of decision rationality this option is also not preferable: It might happen that the developer who moves from decision towards individual action only takes his own suggestion, arguments, and evaluation criteria into account, so that the final level of rationality of the decision is low. Thus, individual action seems to be the worst way to deal with the problem of decision-making and action in FOSS projects. But from the viewpoint of a social structure aiming to develop software, there is one situation that should be avoided at all costs: To be stuck in the development process for a longer period of time.

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