HOW COMMUNITY INNOVATION WORKS

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HOW COMMUNITY INNOVATION WORKS

A MATERIAL-SEMIOTIC ANALYSIS OF THE WIRELESS LEIDEN WI-FI NETWORK

PROEFSCHRIFT

ter verkrijging van
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geboren op 24 december 1976
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Prof. dr. V. A. J. Frissen

en de assistent promotor
Dr. ir. E. C. J. van Oost

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All creative work is collective; science is no exception (for early studies elaborating this point, see Fleck, 1935 and Becker, 1982). Although I am credited as the single author of this PhD thesis, this task could only be completed because much of the invisible work involved was distributed over a larger hybrid collective. This is the place were I thank the human actors who jointly functioned as my infrastructure of support.

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Amsterdam, November 2010

"Work is the link between the visible and the invisible."
Anselm Strauss, quoted in Star (1991c, 265).

Prelude — Users as innovators

> "[L]ook at 2006 through a different lens and you'll see another story, [...] about community and collaboration on a scale never seen before [...] about the many wresting power from the few and helping one another for nothing and how that will not only change the world, but also change the way the world changes. The tool that makes this possible is the World Wide Web. [...] It's a tool for bringing together the small contributions of millions of people and making them matter. [...] And we didn't just watch, we also worked. Like crazy. [...] We're looking at an explosion of productivity and innovation, and it's just getting started, as millions of minds that would otherwise have drowned in obscurity get backhauled into the global intellectual economy. Who are these people? [...] Who has that time and that energy and that passion? The answer is, you do. And for seizing the reins of the global media, for founding and framing the new digital democracy, for working for nothing and beating the pros at their own game, TIME'S Person of the Year for 2006 is you." *TIME Magazine*, 2006, Vol. 168, Issue 27/28, p. 26.

A spectre is haunting innovation; the spectre of the user. Users are 'hot' and populate many press reports on Internet innovation. Popular media convey images of Internet innovation in which users are a sine-qua-non. New buzzwords such as blogs, wikis, social media, twitter, web 2.0, open source, all are examples of community-based innovation in which users play a pivotal role. This 'turn to the user' in popular press, had already taken place earlier in different strands of social studies of innovation. This research replaced a static 'diffusion of technology' perspective, framing users as passive recipients of technology, with a dynamic co-construction perspective framing users as active participants in an interactive and iterative innovation process (Frissen, 2004, 2008; von Hippel, 2005a; Oudshoorn and Pinch, 2003a, 2007; Rohracher, 2005). The history of technology gives ample evidence of this active role of users in innovation. In the case of wireless telegraphy, amateur radio hobbyists pioneered with using the technology to broadcast live or pre-recorded music performances shaping the evolution of modern radio broadcasting (Douglas, 1987). After the intro-

duction of the telephone for business communication, it were rural telephone service transcribers who started to use the device as a social communication tool (Fischer, 1987, 1992). In the case of the French Minitel service, it were hackers who transformed this one-way terminal database system into a two-way communication device, which became extremely popular for anonymous erotic chatting and as such a commercial success (Feenberg, 1995).

Interestingly, the domain of information and communication technologies (ICT) seems to be the domain per excellence in which users play an important role in innovation processes. The recent rise of increasingly globally available electronic communication infrastructures, such as the Internet, enables users to cooperate in new ways and play new roles that were previously limited to professional organizations due to factors of high costs and limited availability. Nowadays, users can engage in new modes of cooperation and take on new roles of collective invention; production; distribution; maintenance; documentation; marketing and support (Lindsay, 2003). In the case of the Internet, it were the daily users who transformed the ARPANET from an American military redundant digital packet-switched routed data network into the Internet as we know it today, as a global general-use platform for creating network infrastructures, by developing applications such as e-mail, Usenet or the World Wide Web (Abbate, 1999; Campbell-Kelly and Aspray, 1996; Berners-Lee and Mark, 1999; Gillies and Cailliau, 2000). In a similar vein, many popular web-services build on the efforts of — often experienced and skillful — users. Examples include the many blogs, pod-casts, and video-casts; customer-written product reviews on Amazon; and the free encyclopedia Wikipedia. This broad increasing involvement of 'ordinary people' in the development of innovations within the domain of ICT illustrates how all kinds of boundaries are blurring into fuzzy areas. Interesting mixed colors appear in the spectrum between producers and consumers. Previously strictly confined categories are eroding and publicly questioned such as experts and lay people, users and designers, consumers and producers, professionals and amateurs, citizens and administrators.

Although there is a general consensus that users are important for innovation, dominant discourses, as exemplified by the TIME magazine cover, seem to suggest that innovation by users is primarily a matter of individual users. This image neglects the fact that many innovations in ICT are the result of a collective endeavor of communities of users. The development of free and open source software, for example, clearly shows how communities of computer users, rather than individuals, develop all sorts of software.[1] Another example, which is the topic of this PhD thesis, is the development of local wireless infrastructures that provide free access to ether commons.[2] In the Dutch college town

[1] A non-comprehensive overview of academic studies on free and open source software (FOSS) is available from http://opensource.mit.edu. Although numerous articles on FOSS have appeared, Lin (2005) states in her assessment of the current literature that "research done from the sociological perspective" is still a lacuna.

[2] This focus on the domain of ICT does not imply innovations by user communities do not occur in other technological domains. Far from it: user-initiated innovations are something that once you start looking for, you see happening in many other domains. Although the empirical study is confined to one empirical domain, the insights fit within general trends towards broader contemporary

of Leiden, a small group of residents managed to develop a town-wide wireless infrastructure (with regional ambitions) offering local residents possibilities for free communication, under the name *Wireless Leiden*. Although there are other major Wi-Fi initiatives, like *Freifunk* in Germany or *DjurslandS.net* in Denmark, the completely wireless 'backbone' of the Leiden infrastructure is technically unique.[3] Within a few years already, the Wireless Leiden initiative had grown to a size that could no longer be neglected (and was not neglected) by other players on the infrastructure market.[4] In 2005, Wireless Leiden started to expand regionally, promoted its activities in other cities, and even built two Wi-Fi nets in Turkey, thus stimulating the potential diffusion of freely accessible wireless communication infrastructures.[5] These Wi-Fi initiatives exemplify the importance of user communities for innovation in ICT.

Based on the case study of Wireless Leiden, the central claim of this dissertation is that innovation by user communities is an important phenomenon, both scientifically as well as socially, that deserves more recognition and a better understanding. Although current scientific literature acknowledges the active contribution of users to producer-lead innovation processes, theories are underdeveloped to analyze innovation processes that are from the very beginning driven by users instead of professional producers. Additionally, because of the trend to reduce innovation to the economical aspects of the creation of financial value within markets, current innovation understate the societal importance of radical user-initiated innovations, simply because they are taking place outside of the domain of the market. Therefore, more research attention needs to be devoted to explore the dynamics that emerge when users, networked with information technology, start to turn novel ideas into working artefacts and common use practices. The central research question of this PhD thesis is therefore: How can we understand the dynamics of innovation by communities of users in ICT networks? In the next chapter I will elaborate the theoretical approach I adopt to answer this question.

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phenomena characteristic for an emerging civil society in which 'ordinary' citizens become more and more actively involved in the shaping of their own technical and social environment.

[3] The group who initiated Wireless Leiden already in 2003 published an article in which they outlined their ideas, how they implemented them and what they learned while doing so. For those interested in an early perspective by actors themselves involved in setting up Wireless Leiden see van Drunen et al. (2003).

[4] At the end of 2005 Wireless Leiden covered most of the Leiden area and registered over thousands of different IP-addresses.

[5] Source: Wireless Leiden press release, available online www.wirelessleiden.nl.

Chapter 1

Innovation by user communities

"To adopt an innovation is to adapt it." Akrich et al. (2002, 209)

1.1 Introduction

As described in the prelude, this PhD thesis aims to understand the dynamics of innovation by communities of users in ICT-networks. For constructing my theoretical framework and to formulate more specific research questions, I draw from two fields of research that address the various roles and influences users have in realizing new innovative products and services. Both Innovation Studies and Science and Technology Studies elaborate the active role of users theoretically and empirically. So far, however, these two fields have taken only limited advantage of each other's insights. In their core literature only few mutual references can be found.[1] Clearly the two domains pursue divergent objectives, as reflected in divergent research agendas. The work in Innovation Studies, particularly but not exclusively the studies of von Hippel and his colleagues, is primarily business-oriented and aims to enhance the quality of a company's innovation processes by making companies aware of users as a potential rich source of innovative ideas for product development. Specifically, von Hippel has developed methods and toolkits for finding and tapping this source. In the field of Science and Technology Studies, by contrast, the focus on users is often inspired by a socio-political and sometimes normative agenda aimed at involving more social groups in technological development and empowering specific user groups. In addition to the difference in research agendas, the two fields use quite different methodologies: if Innovation Studies primarily relies on quantitative methods, the Science and Technology Studies (STS) tradition

[1] This finding is based on the analysis of the three core book publications on user-technology relations, two on user studies in STS (Oudshoorn and Pinch, 2003a; Rohracher, 2005) and one core book from innovation studies (von Hippel, 2005a).

mainly capitalizes on the strategy of "thick description" by doing qualitative case studies.

More recently, however, mutual interest between these two fields seems to be growing and it is possible to observe cautious shifts in agendas and methods. Von Hippel has recently broadened the scope of his work by re-positioning the role of users as more central and essential in innovation processes (von Hippel, 2005a). Instead of depending on what producers offer them, users are considered as actors who are able to develop what they want themselves. This should be considered as a drastic change in conceptualizing users because dominant views of users, particularly but not exclusively articulated by designers, often emphasize that users do not know what they want. This trend toward "democratizing innovation", as von Hippel calls it, is enhanced substantially by the widespread use of Information and Communication Technology. According to von Hippel, this trend is not only relevant for industries and companies, but also for policymakers and various social groups. While in STS circles questions on democratizing technology have topped the research agenda for a long time, more recently the interest in innovation processes has started to grow, even to the extent that today the term Science, Technology and Innovation Studies has grown common.[2] Although there are still fundamental differences in styles of research between STS approaches and Innovation Studies, rising interest in understanding the growing role of users in innovation is evident in both fields. This PhD thesis aims to develop a further dialog between the two fields by explicitly drawing together theoretical concepts from both strands in the analysis of Wireless Leiden as a case study. In the next two sections I discuss how the two fields have conceptualized the innovative agency of users and how these strands of research relate to my research question. In the last section I present my conceptual framework and method.

1.2 Innovation Studies

In this section I give a concise overview of the development of research on user innovation in the field of Innovation Studies, starting with von Hippel's introduction of users as sources of innovation, to recent work on innovation in user communities on the Internet.

1.2.1 The discovery of users as the sources of innovation

The central contribution of the work of the American economist von Hippel to innovation research is that he challenged the conventional wisdom that manufacturers are the primary sources of product innovations. In a publication on "the dominant role of users in the scientific instrument innovation process"

[2] An exemplary illustration is the European Network of Excellence PRIME (Policies and Research on Innovation in the Move towards a European Research Area). Whereas Oudshoorn and Pinch (2003b) only footnoted von Hippel in their overview of the role of users in technology development, they explicitly discuss the user-oriented innovation studies in a review of user-technology relations in 2007 (Oudshoorn and Pinch, 2007).

von Hippel challenged the till-then dominant view that manufacturers were the only sources of product innovations (von Hippel, 1976).

Although scholars prior to von Hippel had already reported how user firms were the sources of important innovations, they did not pursue this line of inquiry more theoretically. Other academics such as Rogers, who introduced the concept of reinvention (Rogers et al., 1978; Rice and Rogers, 1980), Rosenberg who introduced the notion of learning-by-using (Rosenberg, 1982), and Lundvall who focused on user-producer interactions (Lundvall, 1988), more generally stressed the importance of users in the innovation process. However, none of them have devoted so much attention towards user innovation as von Hippel. His long-term and sustained study of the active role of users in innovation has put the innovative agency of users firmly on the agenda of Innovation Studies. The pioneering work of von Hippel sparked an increase in research on the role of users in innovation.

This increased sensitivity towards users, can be understood as part of a wider trend within economics to move away from linear views on innovation towards perspectives conceptualizing innovation as complex, interactive and iterative 'systems' in which many actors are simultaneously involved. In line with this development, von Hippel for instance framed his work as "a view of innovation as a process that is predictably distributed across innovation users, manufacturers, suppliers, and others" (von Hippel, 1988, 117).

Let us have a look at how von Hippel conceptualized this user-initiated distributed innovation process. In an empirical study on the sources of innovation in the domain of scientific instruments von Hippel (1976), he described how users were often the sources of product innovations or improvements. Users not only came up with new ideas, but also built prototypes and actively diffused information about the invention to others. In many cases, the role of instrument firms was confined to the commercialization of the invention by manufacturing, marketing and selling the innovation, thus making the innovation widely available to others. Without the role of the manufacturers the information about the innovations would stay confined to the local environment in which the invention took place. Additionally, most users have no incentive to actually make available their innovations because their main incentive lies in using technology, and not producing and making it commercially available. To summarize, von Hippel's major argument was that both users and producers are actively involved in the innovation process, but play different roles at different times.

In this process, he identified the following pattern of recurring steps in user-initiated innovation, schematically summarized (see figure 1.1a on page 11). Von Hippel (1976, 220-1) states that, first the users:

> "-Perceived that an advance in instrumentation is required.
> - Invented the instrument.
> - Built a prototype.
> - Proved the prototype's value by applying it.
> - Diffused detailed information on both the value of the invention and on how the prototype device could be replicated."

And second, the manufacturers then:

> "- Performed product engineering work on the user's device to improve its reliability and convenience of operation.
> - [M]anufactured, marketed, and sold the innovative product."

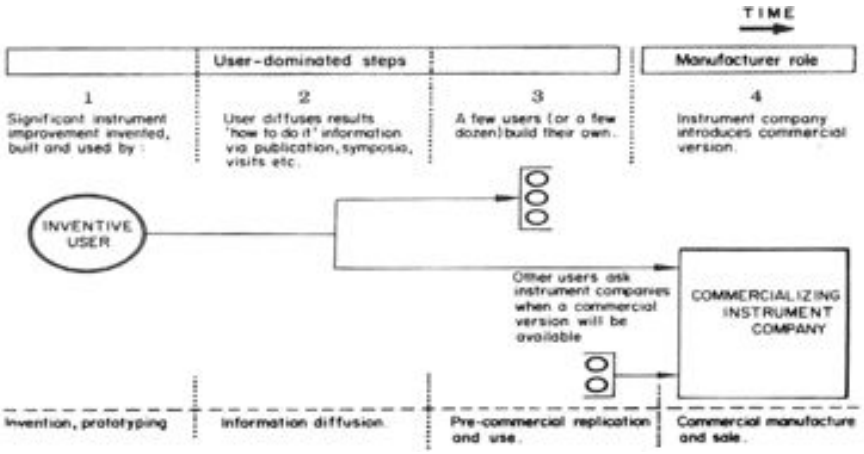
In this conceptualization of innovation users do almost all the work themselves, and "only 'commercial innovation' is carried out by the manufacturer" (von Hippel, 1976, 227). One could also say that only manufacturers have the incentive, expertise and production infrastructure to commercialize the innovation by making it available to the market. In this view, the producer is no longer the initiator of the innovation, but an intermediary translating an innovation from the domain of 'homebuilt' inventions to meet the demands of the domain of commercial ready-made products (see figure 1.1b on the next page).

It is important to note that in the early research on user innovation in the 1970s and 1980s, users are almost exclusively conceptualized as firms or organizations, and not as consumers or citizens. Sometimes a user (organization or firm) can thus be many times bigger in number of employees than a producer (firm). In the same manner, when product innovations are discussed, industrial goods are meant, and not consumer goods. In this sense the early studies on user innovation are confined to the locus of professional organizations. As I will describe below, only fairly recently empirical studies were done on user innovation in the field of consumer goods.[3]

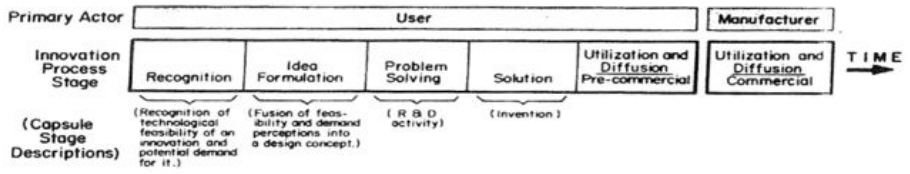
1.2.2 Introducing lead users

After concluding that users can be and often actually are innovators, one of the questions that emerged in Innovation Studies was if certain types of users are more likely to innovate than others, and if so why. As a means to answer this question von Hippel introduced the lead user concept which enabled him to classify a special type of users who where much more likely to innovate than other types of users (von Hippel, 1986). Lead users of a novel product, process or service display two distinctive characteristics. Lead users are users who firstly "face needs that will be general in a marketplace — but face them months or years before the bulk of that marketplace encounters them," and, secondly, they are positioned "to benefit significantly by obtaining a solution to those needs" (von Hippel, 1986, 796). This combination leads to the situation where a small

[3] In many cases the distinction between professional users and users as consumers or citizens is not always so clear and mainly an analytical construct: for example whether text processing software is used at work, at home, at school or while traveling on a laptop, in the end people are all doing the same. The same holds true for the distinction between industrial and consumer goods; nowadays in the domain of software both professionals and consumers often use the same programs. In this sense it is much more interesting to study actual use practices in which users come up with innovations, than to try to artificially categorize innovative uses into the correct category. In the end, people are using technologies to achieve a certain goal, regardless if they are a 'professional' or a 'consumer'. Besides that often the same actors are both user and producer with regard to different technologies, or to the same technologies at different times. A much more interesting question then becomes if there is a difference between certain types of users or use practices in relation to the occurrence of user innovation.



(a) Typical steps in the invention and diffusion of a scientific instrument (von Hippel 1976, 220).



(b) The primary actor in each innovation process stage (von Hippel 1976, 228).

Figure 1.1: Users as sources of innovation (von Hippel 1976)

group of users are badly in need of a solution. However, manufacturers may not be informed about this need, and if so may have no incentive to actually produce this solution because of the small size of the market. This lack of commercially available solutions, may then direct some lead users into the creation of their own solution. The actual user-innovators are thus again a subset of the lead user population. So in short: "lead users can — and often do, but need not — invent, design, and build their own solutions to suit their needs" (von Hippel, 1986).

It is important to note that lead users are not the same as 'early adopters' (Rogers, 1995, 264). Lead users are experiencing needs for which there is no commercial solution on the market available yet. Early adopters are the first buyers of something that is commercially available on the market. However, both concepts share that they involve actors who are ahead of a certain trend (often visualized as S-shaped curve) that will appear in the future. This makes both of them ex posteriori concepts, because they describe characteristics that are related to a technological trend developing over time. In this sense the same actors can be lead users in relation to one trend, but normal or even non-users in relation to another technological trend. So when speaking of lead users, it is important to explicitly mention what trend they are leading and what it is that they are lead users of. Additionally, it is important to stress that the 'lead-user-ness' or 'early-adopter-ness' is no essential quality that exists within the actor, but only exists on an conceptual level as an analytical construct. However, in daily life and popular media, terms such as early adopters or lead users have grown a life of their own. For example, nowadays 'early adopters' (or even 'adapters') are usually associated with the stereotypical image of high-income, young, urban males who love the 'latest and greatest' highly complicated and expensive gadgets. Although the phenomenon of males presenting an image about their identities constructed around gadgets in the same way as some stereotypes suggest women do in a similar manner with expensive clothes and jewelry, using these concepts in this way is absolutely not what was originally meant with the lead user or early adopter concepts.

The introduction of the concept of lead users, not only contributed to a better academic understanding of user innovation, but also to a corporate tool called the 'Lead User Method' which can actually help companies to find user-innovations which they then can commercialize. By now, an extensive body literature exists on the Lead User Method, and companies such as 3M or Philips actively employ it (von Hippel, 1986; Urban and von Hippel, 1988; Herstatt and von Hippel, 1992; von Hippel et al., 1999; Lilien et al., 2002).

Since lead users are aware of future market needs, they potentially serve as an excellent "need-forecasting laboratory for marketing research" (von Hippel, 1986, 791). By emphasizing lead users as a rich resource for corporate innovation, von Hippel elaborated a methodology for marketing departments to identify lead users as representing the needs of the future market. As such they possibly play a major part in the design of prototypes of new products. Von Hippel (1988) describes how in 3M actively tracking lead users, and then inviting them for workshop meetings in the end delivered new products with a revenue

worth of millions of dollars. Using the lead-user methodology companies can tap into the user population as a new resource for developing innovations. In order to prevent problems with authorship of the intellectual property of innovations, participating lead users are asked to sign contract to officially waiving away any claims to authorship of the idea. In short the lead user method consists of four basic steps:

> "1. Identify an important market or technical trend.
> 2. Identify lead users who lead that trend in terms of (a) experience and (b) intensity of that need.
> 3. Analyze lead user need data.
> 4. Project lead user data onto the general market of interest."(von Hippel, 1986, 797)

The fact that Innovation Studies not only generates theoretical knowledge, but is also actively involved in changing corporate innovation practices, shows its 'interventionist agenda' (Oudshoorn and Pinch, 2007). Besides academic papers on the Lead User Method, also popularized articles, practical how-to manuals, 'lead user consultancy' services and even video tutorials are available.3 An explicit aim of Innovation Studies is thus to facilitate firms to increase their 'innovativeness'. On a macro-scale recognizing the innovative capacity of users could also carry implications for innovation policy on the 'systems' level (von Hippel, 1988, 120-122).

1.2.3 The innovative agency of communities

The Innovation Studies literature described thus far has one common nominator: it portrays user innovativeness as an individual endeavor, thus echoing and reinforcing the figure of the individual engineer as major source of innovation. Indeed, for a long time research in Innovation Studies remained restricted to the innovative agency of individual users. It was only in the late 1990s that this field began to identify new types of user innovations, in which no longer individual user-innovators were the source of innovation, but groups of cooperating users collectively developing innovations.[4] More recently, the rise of the Internet in general and open source communities in particular has boosted interest among scholars in Innovation Studies for innovations by user collectives, especially the phenomenon of non-profit technology collectives. To capture the dynamics of open source communities various concepts were developed: private-collective innovation (von Hippel and von Krogh, 2003), commons-based peer production (Benkler, 2002a), as well as community-based innovation (Franke and Shah, 2003; Shah, 2005).

In 2005 von Hippel compiled this recent cluster of publications in *Democratizing Innovation*. This is where he introduced the overarching concept

[4] More generally starting from the 1990s, within economics and organization sciences an increased attention towards a new unit of analysis, namely the community, emerged. Callon (2004, 3-4) summarizes this development as: "To describe these new forms of organization, economists and management scientists have proposed the notion of community". Also, see Amin and Cohendet (2004), Knorr-Cetina (1999), Lave and Wenger (1991), Callon and Law (1995).

of "innovation community" defined as an organized cooperation in the development, testing and diffusion of user-initiated innovations. Users as well as manufacturers can be members; the innovation community can be purely functional but may also fulfill the role of a social (virtual) community providing sociability, support, a sense of belonging, and social identity (von Hippel, 2005a, 96). Although von Hippel defines innovation community broadly, he has mainly addressed and analyzed it as a locus or setting for exchanging innovative ideas and information among involved individual community members. As I will describe in section 3, based on work in STS we have reason to expect that activities of innovation communities also involve collective work aimed at creating and sustaining and stable networks.

1.2.4 Prioritizing economy and black boxing technology

Reflecting on the Innovation Studies' literature described above, we can conclude that this field has produced a wealth of concepts and data on the active role of individual users and user communities in innovation. Especially the concept of the lead user can be particularly useful as a heuristic concept to trace innovating users. In addition the concept of the innovation community (von Hippel, 2005a) seems very useful for this PhD thesis because the community aspect is central to the development of Wireless Leiden. Although these Innovation Studies' concepts focus the researchers attention on the right place and actors, there are two key perspectives in this field that constrain an adequate understanding of innovation by user collectives.

In the first place innovation studies frames user-initiated innovation within an economic perspective. Of course nothing else is to be expected from the discipline of Innovation Studies that is rooted within economics. However, this means that certain characteristics of user innovation are fore grounded as more important, while others are back grounded as trivialities or left out completely. Although the view that users can be, and often are, the source of innovations is in itself a very important insight, in the early studies on user-initiated innovation the term user was meant to describe a user firm or organization involved in innovating industrial goods. It goes without saying that an economic perspective on innovation is very suitable to understand these kind of user-initiated innovation practices. Since the 1990s, there is an interesting shift in focus towards including consumer goods in which it is shown that user innovation need not be limited to industrial goods or firms but that consumers can be involved in innovation practices as well. These studies on consumers as user-innovators focus primarily on the empirical domains of sporting equipment and open source software, particularly the practices of extreme or specific types of sports; for example, kite-surfing, mountain biking, or rodeo kayaking and handicapped sport (Hienerth, 2006; Lüthje et al., 2005; Franke and Shah, 2003; Shah, 2000). Although this shift towards consumer goods might have included a broader perspective on innovation than strict economic incentives, the very choice of these examples still reflects an underlying conceptualization of an innovation as something that is successfully commercialized. In the same

manner as users where first primarily conceptualized as firms and only later-on consumers were deemed interesting enough to study empirically, the development of sport equipment by users is considered relevant only because these devices are successfully introduced on the market. Consequently, innovation itself is primarily framed in terms of its commercial existence in the market. This then goes back to the difference between an invention, and an innovation, on which linear innovation models (e.g. Rogers' diffusion model) are based. If there is no 'product' commercially available on the market, as was for example initially the case with free software, strictly speaking then there is no innovation. Unless you change the definition of what an innovation embodies. In this sense there is an inherent bias within economic-inspired Innovation Studies to value phenomena that do not fit within the capitalist market model as less relevant. It goes without saying that this conceptualization of innovation is not confined to Innovation Studies. Even today, there is a strong bias amongst economists as well as policy makers and corporate managers that innovation equates economic growth. Innovations are necessary to tap into new markets, to maintain high margins and to win the battle against competing low-wage economies in India or China. Nonetheless, especially the studies on open source software, have made clear that innovations that are formatted along the rules of different value systems, such as those based on reputation, personal skills development, ideological values or simply 'for fun', can still produce high-quality technology.[5] This triggers the important question how we can explain innovations in which inventing, developing, producing, distributing, marketing, servicing and maintaining technologies for free are done by non-paid volunteers, hobbyists and driven by enthusiasm, which in itself can be considered as an innovation, even if it doesn't immediately fit into the capitalist market model. How can we study and understand innovations by communities of users that are not primarily inspired by economic values?

A second perspective in Innovation Studies that constrains an adequate understanding of the dynamics of innovation by user communities is that these studies leave the black box of technology closed. Generally speaking technology itself is not considered to play an active role within user innovation. It is either the outcome of user innovation, or it is seen as a tool facilitating certain types of actors to engage in user innovation. One of the few exceptions that explicitly explores the relation between the material design of artifacts and user innovation by modifying the artifact is von Hippel and Finkelstein (1979). Functionally similar products with different designs can enable or constrain end-users to modify these products in different ways. Closed products, that take a lot of work to modify, constrain end-user innovation while open products, that enable end-users to modify the operation characteristics, invite and facilitate end-user innovation. Additionally, these papers suggests that 'open' and 'user innovation friendly' designs ultimately might be more successful commercially due to increased instrument sales (von Hippel and Finkelstein, 1979, 35). One could also conclude that 'open' artifacts have a greater 'solution space' than

[5] As an example of the 'for fun' aspect, see Torvalds and Diamond (2002) telling the story of how Linus Torvalds initiated the open source operating system Linux.

closed artifacts. Another interesting conclusion of this study is that the material design of products relates directly to corporations' profit strategies. This means that corporate profit-strategies are 'coded' into the design of the product. If user-modification and experimentation is not deemed to fit in with the commercial strategy, then the design is such as to maximally constrain users in their freedom of uses.[6] One could say, that company politics are encoded into the product designs (see Winner, 1980). Although von Hippel and Finkelstein thus identified the importance of the materiality of artifacts as directly enabling or constraining user innovation practices, they did not pursue this theme in their later work. Consequently, Innovations Studies lacks conceptual tools for understanding the agency of technological devices and the work involved in aligning technical and social elements of bottom-up innovation by user collecties.

1.3 Science and Technology Studies

In Science and Technology Studies, as in Innovation Studies, the innovative agency of users in the dynamics of technological developments has drawn considerably attention since several decades already. In this section I give a short impression of three approaches to user-technology relations developed in this field and describe how one approach in particular, Actor Network Theory (ANT), enables me to develop a conceptual framework to study innovations by user communities that goes beyond a primarily economic perspective and opens the black box of technology.

1.3.1 Users as active agents in socio-technical change

For a long time, Science and Technology Studies were primarily concerned with the role of scientists and engineers in the development of new technologies.[7] Interestingly, feminist scholars have played a leading role in drawing attention to users in innovation. Feminists' interest in users was primarily related to their concern with the potential negative consequences of technologies for women and the absence of women in historical studies of technology.[8] Since the mid-1980s, feminist historians have pointed to the neglect of women's role in the development of technology. In response to this criticism, users were gradually included in the research agenda of historians of technology. As Oudshoorn and Pinch (2003b) have described, this 'turn to the users' can be traced back to Ruth Schwartz Cowan's exemplary research of user-technology relations. To conceptualize the active role of users in innovation, she introduced the notion

[6] The same point is made in a book on 'hacking' (Grand et al., 2004) where as one of the motives for hacking consumer goods is to overcome limited capabilities that have no 'technical' cause, but were designed into the product for profit-maximizing purposes.

[7] The discussion of feminist studies and the SCOT approach to user-technology relations presented in this section is based on the introductory chapter of How Users Matter (Oudshoorn and Pinch, 2003b, 3-7).

[8] See for example Cockburn (1985); Cowan (1983)Faulkner and Arnold (1985); Oudshoorn (1994); Oldenziel (1999); Saetnan et al. (2000); Wajcman (1991).

of 'the consumption junction', defined as 'the place and time at which the consumer makes choices between competing technologies' (Cowan, 1987, 263). Cowan argued that a focus on consumers and the network relations in which they are embedded enables historians and sociologists of technology to improve their understanding of success and failures of technologies. The scholarship that Cowan inspired rejects the idea that science and technology begin or end with the actions of scientists and engineers. Scholars in Science and Technology Studies were urged to follow technologies all the way to the users (Rapp, 1998, 48).

A second theoretical perspective in STS that acknowledged the agency of users in technological development right from the start is the social construction of technology (SCOT) approach developed by Trevor Pinch and Wiebe Bijker (Pinch and Bijker, 1984). In this approach, users are conceived as one of the 'relevant social groups' who play an important role in the construction of a technology. Different social groups, including users groups, are conceptualized as actors who construct radically different meanings of a technology, a process referred to as a technology's 'interpretative flexibility'. To understand the success or failures of innovations, or in SCOT terms socio-technical change, Pinch and Bijker specified a number of different closure mechanisms, social processes whereby interpretative flexibility is curtailed (Bijker et al., 1987; Bijker, 1995b). By introducing the notion of 'socio-technical ensemble', the SCOT approach emphasized that innovations should be understood as the result of the mutual shaping of technologies and social groups, including users (Bijker, 1995b). Most importantly, Kline and Pinch showed how users can adopt an active role in the redesign of an artefact, independently of the producer, referring to these users as 'agents of technological change' (Kline and Pinch, 1996). This approach suggests a different view of the innovative agency of users then offered by Innovations Studies where innovation by users always includes a feedback loop via producers.

1.3.2 User communities as hybrid collectives

Although feminist scholarship and the SCOT approach have been very influential and productive in re-conceptualizing users from passive consumers to active participants in innovation and opening the black box of technology, most of the studies inspired by this scholarship granted agency primarily to humans and not to the materiality of technologies.[9] As Innovation Studies, these approaches don't conceive technology as actor. To understand the dynamics of innovation by communities of users, I suggest it is important to conceptualize both users and technologies as actors, a perspective that is central in another approach developed by scholars in Science and Technology Studies: actor network theory (ANT). ANT scholars extended semiotics, the study of how meanings are built, from signs to technologies. This material-semiotic perspective on technologies enables a symmetrical analysis of the interactions between people

[9] For a notable exception in feminist scholarship see Donna Haraways' work on cyborgs (Haraway, 1985), reprinted in (Haraway, 1991).

and technological devices, which is one of the most important merits of ANT. Scholars working in this tradition who explicitly addressed the agency of users are Steve Woolgar and Madeleine Akrich. Exploring the metaphor of machine as text, Steve Woolgar (1991) has introduced the notion of 'configuring the user' in which he conceptualized the user as reader. He suggested that how users 'read' machines is constrained because the design and the production of machines entails a process of configuring the user. According to Woolgar 'configuring' is the process of 'defining the identity of putative users, and setting constraints upon their likely future actions.' (Woolgar, 1991, 59). As Woolgar, Akrich also conceptualized the user as reader and introduced the concept of script to capture the interactions between designers, users and artefacts.[10] The script concept explicitly related artifacts and their usage by suggesting that all designers base their products on envisioned users and specific use situations (Akrich, 1992). Accordingly, products contain a script, which is the materialized presentation of envisioned use. The use of a product is described in semiotic terms as the 'reading' of its script. In this reading — which essentially involves adapting the new product to user environments — the meanings, uses, or even the products themselves can be changed and adapted. Users may very well read scripts in ways that differ from those intended by the designer.

Although the notions of 'configuring the user' and 'script' provide useful heuristic tools to analyze the active role of users and technologies in innovation, they tend to focus primarily on the interactions between artefacts and individual users, which make these concepts less useful for the analysis of innovation by user communities. What is needed to be able to describe bottom-up initiatives by groups of users, is a theoretical framework that can deal with the dynamics of multiple actors interacting on multiple levels to be able to map the interaction between groups of 'users' fulfilling different roles and different artifacts, in different socio-technological networks. Equally important, innovation by user collectives takes place in networks. Networks that consist of people and material artifacts, in constantly changing combinations. Communication and information exchange between human actors is technologically mediated, but at the same time the human actors define the meanings of new technology by experimenting with them, and using them in novel ways or contexts. To understand the complex dynamic interactions between all these different human and non-human elements woven together in a 'seamless web' (Hughes, 1987), it is not possible to leave out one of the two, because the identities of the elements that make up the network are constituted in their mutual relationships. To capture this network character of the interactions between humans and non-humans, Michel Callon introduced the concept of 'hybrid collective' (Callon and Law, 1995). In contrast to the ANT concepts discussed above, the notion of hybrid collective takes into account the network-character of technology and considers innovation as a collective endeavor, thus providing a very useful concept for analyzing community-based innovation processes. Equally important, the concept enables me to take into account the material

[10] For a more detailed discussion and analysis of the differences between Woolgar's and Akrich' approach to user-technology relations see Oudshoorn and Pinch (2003b).

agency of artifacts within such cooperative collectives of individuals and their enabling and constraining influence, an aspect that is missing in von Hippel's concept of innovation community described above. My point of departure in this dissertation is therefore that innovation by user groups can best be described in terms of collective, hybrid, and distributed processes. Following ANT, I view innovation by user collectives as a process of building heterogeneous networks among and between humans and non-humans. The longer the network, the more robust it is, and also more sustainable.

This is not to argue that networks are static once they are put in place. Studies adopting an ANT approach have indicated that heterogeneous networks, once in place, need continuous work to keep the network from falling apart. Madeleine Akrich, Michel Callon and Bruno Latour offer a compelling illustration of this complexity by comparing innovation processes with the launch of rocket into space:

> "[I]magine a rocket, pointed towards a planet whose long-term trajectory is unknown, taking off from a moving platform whose co-ordinates are only crudely calculated; additionally, imagine a division of tasks whereby some specialise in observing the planet, some in calculating the location of the platform, and others in defining the power of the engines; finally, imagine decision-makers who at all times need to consider the occasionally incompatible information produced by all of the specialists." (Akrich et al., 2002, 189)

What emerges from this illustration is that the activities of coordinating, communicating and cooperating are of vital importance for innovation 'missions' to be able to succeed. There is no inherent difference here between commercial innovation and bottom-up innovations by user collectives. However, in the case of commercial innovation, its degree of success is measured in terms of market 'penetration' or 'dominance'. This means that innovation work does not end when innovations enter the market. Or, to extend the rocket-launch-metaphor, the work doesn't end when the rocket leaves the launch platform; only when consumers' credit cards have been hit, the operation can be considered a success. Thus once an innovation missile is launched and escapes earth's atmosphere, it still remains in need of careful monitoring, both remote as well as local, adjusting in case of unexpected events. This is what often is captured as the activity of 'marketing'; and it is considered part of the innovation process. However, what happens once the customer has taken over ownership, the fate of the innovation is out of the hands of its original creators? At least, after the legally demanded guarantee period has passed. Or unless, the innovation is part of a razor-and-blade business model, depending on after-sales for profitability. All in all, commercial innovation is quite a complicated operation, inherently unpredictable because of systematic complexity of which the irrational behavior of whimsical consumers is one of the critical variables.

Now imagine an innovation by user collectives, where all the work is done by only loosely connected groups of unpaid people, spending their time mostly

in weekends and after-work hours; often without the availability of a physical launch control centre, instead working from their own attics or bike sheds, communicating with each other by e-mail, telephone and hand-written post-it notes affixed to stuff waiting to be looked after by other people, only occasionally meeting in real person; and where the space craft itself (the materialization of the innovation) is being built through iterative trial-and-error cycles, remotely reconfigured in-flight based on complaints by users that things have stopped functioning, assembled from a combination of common house-hold objects, recycled computer junk and cheap consumer stuff, hold together by patchy code, duct-tape, tie-wraps and then some additional rusty nuts-and-bolts.

Although this setup makes the innovation network quite flexible for cheap modifications and convenient experimentation in terms of money and time, the drawback of this structural transiency is the in-built need for constant repair. Paying attention to all the work involved in the building and sustaining heterogeneous networks is thus crucial for understanding the dynamics of community-based innovation.

1.3.3 Focus on work

Reflecting on the previous section, we can conclude that the material-semiotic approach is very promising for understanding the dynamics of innovation by user collectives. First, because it does not black box technology by conceptualizing artifacts as agents. Second, because of its view on innovation as a collective endeavor. However, there is one pitfall we should avoid. A much debated criticism on ANT was its 'machiavellistic' character, stressing the importance of powerful network builders, and its political vocabulary using words like 'alliances' and 'coalitions'. Especially feminist scholars criticized the bias of ANT towards powerful actors caused by its 'follow the actors' methodology, leading to an 'executive approach'. The unintended consequence of this approach was that the voices of less powerful or visible actors such as technicians, secretaries, or women were made invisible in these accounts of the development of technology (Clarke, 1998; van Kammen, 2000; Star, 1991c,a, 45)[11] The 'executive approach' was also criticized because of its strong preference towards putting research attention on the design-side of innovation processes, and focusing much less attention on the use-side.[12] Although ANT's focus on heterogeneous networks of both human and non-humans makes it possible to include all actors in the analysis, one has to be careful when 'following the actors'. For example, when studying community-based innovation one may be tempted to follow the 'lead users' because their work is often fore grounded in the academic literature as well as news media.

[11] See (Oudshoorn and Pinch, 2003b, 7) for a more detailed discussion of this criticism on actor network theory.

[12] Some notable exceptions are Callon and Rabeharisoa (2003); Moser and Law (1998); Moser (2000); Moser and Law (2001), who repaired this imbalance to some extent by extending actor network theory to include the study of 'subject networks'. They introduced this notion to refer to processes of attachment between users and technologies, particularly but not exclusively between disabled people and assistive technologies (Oudshoorn and Pinch, 2003b, 11).

To avoid an executive approach, I suggest it is important to include an explicit focus on work. In this PhD thesis I aim to unravel the different types of work of all actors involved in community-based innovation, not only the lead users but also the users that are often described as end-users.[13] Or to rephrase it in ANT terminology: my aim is to analyze all the work human and non-human actors invest in building and sustaining networks, in which I do not assume that one node or actor in the network is more important than others. My point of departure is that the work involved in building and sustaining hybrid collectives is distributed over the entire network. This conceptualization is important because it enables me to go beyond a reiteration of stereotypical identities of the actors and their work. In the case of innovation by user collectives, technical tinkering or management work may not necessarily be delegated to lead users or managers but to end-users and technical devices, or other actors as well. The core of my argument is that to understand the dynamics of community-based innovation certain types of work is as necessary as other kinds of work, although some actions may be more explicitly valued than others.

My choice to focus on work is inspired by researchers working in the tradition of symbolic interactionism, most notably Anselm Strauss, Leigh Star and Lucy Suchman, who have done important research to understand what they called the 'ecology of visible and invisible work' (Strauss, 1985; Star and Strauss, 1999; Suchman, 2002). With this notion, they referred to the neglect of representing specific knowledge and skills as formal work. They argued that the question of 'what counts as work' makes specific expertise and specific groups of actors invisible. This research agenda of studying invisible work emerged as a criticism on cultural shifts in the 1980s and 1990s that neglected the expertise of so-called unskilled laborers, most notably housewives, cleaners, and file-clerks. Consequently, scholars set out to make visible "the expertise often hidden from view" (Star and Strauss, 1999, 11), "work that goes unnoticed or is not formally recognized" (Star, 1999, 386). The study of invisible work has been very central in the field of computer-supported cooperative work as a criticism on the narrow focus on 'production work' among social scientists and designers that may explain the frequent failures or resistances to innovation in this domain. Star and others stressed the importance of extending the conceptualisation of work to include 'the hidden task of articulation work', a term they introduced to refer to the invisible work involved in making technologies, or "work that gets things back 'on track' in the face of the unexpected, and modifies action to accommodate unanticipated contingencies" (Strauss, 1985; Star, 1999; Schmidt and Simone, 1996, 387). This approach towards work thus seems to be very appropriate to make up for absences of specific aspects of human work and expertise in formal representations and rationalized models of work underlying the design and use of technologies.

My strategy to label the activities involved in innovation by user collectives as work has, however, a different aim. In most studies on community-based innovation, the work involved in building heterogeneous networks is often rendered invisible, or as Star formulated this: 'the prior and ongoing work

[13] For a discussion of different type of users, see Friedman and Cornford (1989, 169-188).

disappears into the doneness' (cited in Callon, 1998, 266). Either because it is assumed that activities involved in aligning humans and non-humans is the result of a self-organizing process that follows fixed mechanisms, or, even more problematic, because these studies adopt a strict economic perspective on innovation. Due to the latter, only the activities involved in community-based innovation that result in commercial products or a new firm are considered as work and deemed worthy to study. In contrast, I argue that activities involved in innovations by user collectives, even if they do not have an explicit economic value or are not related to the market, should be considered as work that produces a certain value. In this respect, the notion of 'economy of qualities' nicely captures my argument (Callon et al., 2002). My choice to label actions involved in community-based innovation as work is not only relevant as critical intervention in Innovation Studies, it is also relevant for the communities themselves because most of the activities take place backstage and are, as such, invisible. By labelling these innovation activities as work, I want to give voice to these novel forms of innovation that are largely absent in dominant discourses on innovation.

1.4 Methods

In this section I describe my conceptual framework, research questions and method.

1.4.1 Conceptual framework

Drawing together the insights of Innovation Studies and Science and Technology Studies described in the previous sections, I introduce the following conceptualisation of innovation by user collectives:

- Innovation by user collectives is an activity of network-building,
- The resulting heterogeneous networks can be described as hybrid collectives,
- Building and sustaining hybrid collectives requires work,
- This work is distributed over the network and involves the full spectrum of users from lead-users to end-users as well as non-human actors.

1.4.2 Research questions

Based on this conceptual framework, this PhD-thesis aims to study the work involved in building and sustaining networks between humans and non-humans. My initial research question articulated in the Prelude of this dissertation, can thus be reformulated as follows:

What types of work are involved in building and sustaining the hybrid collective of an innovative ICT-based user collective?

To answer this question, the connecting thread throughout the following four empirical chapters is the analysis of the different kinds of work involved in community-based innovation practices. The first question I will address is how heterogeneous networks are built. What kind of work is involved in creating alliances between human and non-human actors? How do lead-users and other actors succeed in aligning the different elements of the network? Because innovations can only become successful if the network is extended to include new actors, a next step in understanding the dynamics of innovation by user collectives is to unravel how the local network becomes extended to new places. In the case of community-based innovations such as Wireless Leiden, this involved the residences of home users. What happens when other kind of users than lead users become part of the hybrid collective? What kind of work is involved linking the local networks of home users to the network of Wireless Leiden and who is doing this work? Equally important, we should pay attention to the question of what keeps hybrid collectives together. As described in section 3.2. heterogeneous networks, once in place, need continuous work to keep them from falling apart. Hybrid collectives are never fully stabilized, but instead these are in constant need of reinforcement by maintenance and repair. This question is even more urgent in the case of community-based innovation because stabilization of the networks cannot rely on paid professionals or institutionalized infrastructures of established organizations, as is the case in innovation in the commercial sector. Analyzing the work involved in the maintenance of the hybrid collective is thus crucial to understand innovation by user collectives. Finally, I suggest it is important to address the work involved in aligning the different values that are at stake in community-based innovation. What makes innovation by user collectives different from innovation in industry of other commercial organizations is that the incentives to innovate are not restricted to economic interests. To the contrary, community-based innovations usually emerge from a different set of values than purely economic incentives, such as openness and sharing innovations. We thus may wonder how innovative user collectives manage to create a stable environment in which these different values are aligned.

The sub-questions of this PhD-thesis can be summarized as follows:

- *What work is involved in creating alliances and building connections between the human and non-human actors?*
- *What work is involved in extending the network into new places?*
- *What work is required in the maintenance of this hybrid collective?*
- *What work is involved in sustaining the network in order to align the different values involved in community-based innovation?*

1.4.3 Case-study of Wireless Leiden

The theoretical approach and questions that are central in this PhD-thesis have led me to embrace an explorative qualitative approach based on an in-depth case study (Yin, 2006, 2003). My choice for a single case-study enables me to make a detailed analysis of all actors and work involved in one specific practice of community-based innovation. As described in the Prelude, I decided to focus on Wireless Leiden, an innovation by a user collective that is exemplary of other, similar Wi-Fi based innovative user collectives in Europe. In the literature on this topic two distinct Wi-Fi communities are defined. The first type is called the 'local loop' model, where Wi-Fi networks provide residents of a usually remote area with Internet access. Users are not interested in the special characteristics of the wireless Wi-Fi technology itself, but in the access to broadband, always-on Internet access. In the Netherlands examples of these are DurgerLan and LomboXnet. For realizing the end goal the end-user is not interested in the specific technology to get the Internet 'into their homes'. The only distinction with commercial Wi-Fi access points is the fact that a local community organized their own initiative to get Internet access to their homes, because government and telecommunication companies do not deliver cost-efficient solutions in lowly populated areas. The second type is the 'local Wi-Fi community', where Internet access is not the main reason to build a local wireless computer network. Central to these innovative user collectives is the incentive of developing new communication services specifically targeted to the local community. Wireless Leiden is an interesting example because it is located somewhere between the local loop model and the local wireless community. In the city of Leiden, one of the initial reasons for building the wireless network was the lack of ADSL-based Internet access, whereas at the same time in the rest of the Netherlands ADSL was becoming available. Compared to other community wireless networks in the Netherlands, Wireless Leiden is also the most sustainable project, measured in terms of infrastructural (back-bone) network nodes, number of users, successful partnerships, and heterogeneity of their end-user group. It is also interesting that the project defines itself explicitly as both 'successful' and 'innovative' on their website. In addition to this, Wireless Leiden seems to include the most heterogeneous group of users when compared to other wireless networks. Members who are interested in the different aspects (the technical, financial and social) are involved in the project. Wireless Leiden also seems to have handled the scaling up of its user population very well. Finally, this user collective developed many innovations that are used in other domains as well, which is one of the main reasons of heir existence. One of the foundations on which Wireless Leiden built their organization is openness, and 'doing things the open source way' (report of the monthly Wireless Leiden foundation meetings). This implies that this user collective does not only share their software code, their configuration scripts or blueprints of their home-built Wi-Fi technology, but also their sponsor contracts, volunteer arrangements, the organizational structure of their foundation, training manuals and 'hands-on' experience with knowledge transfer both within their own community as well

as to other organizations. Summarizing I conclude that Wireless Leiden thus provides a very rich case-study to understand the processes of innovation by user collectives. More specifically, I decided to choose Wireless Leiden as case study because

1. it exemplifies a bottom-up innovation,
2. it concerns an innovation driven by a collective of users rather than individual users,
3. it involves a grass root, non-profit organization,
4. it enables me to open the blackbox of the collective of users as well as the collective of technologies

For my data collection, I relied on three strategies.[14] First I explored all the information provided on the Wireless Leiden website.[15] This site proved to be a tremendously rich source, because — fully in the tradition of open source communities — maximum transparency is strived for regarding both material and organizational aspects.[16] Minutes of meetings, discussions, and debates were made available online, as well as many technical descriptions, guidelines, and images of the various stages of the technological developments involved. Second I interviewed around thirty actors involved in or related to Wireless Leiden. Most of these in-depth interviews took place at the home or at work, or in one of the different buildings the WL 'office' was housed. However, if this was not feasible — for example one of the respondents had continued his volunteer involvement in WL after relocating from Leiden (NL) to Boston (US) — the interviews took place over the phone. Third I observed around thirty 'events' in the period 2005-2008, most of which took place in Leiden and its surroundings. At these events I observed a range of different types of activities, such as discussions, presentations, workshops, board meetings, node building meetings, during which participants engaged in different types of technology practices, such as designing, building, reverse-engineering, deconstructing, maintaining, testing, updating or repairing technologies. Often, before, during or after observing such events, I interviewed participants in-situ in an informal manner. Finally, I order to convey a sense of the local settings, I have included some photographs of key activities of actors involved in Wireless Leiden, as well as techno-biographical elements.[17]

[14] For an overview of all empirical sources consulted for this PhD thesis, enlisting interviews, observations and electronic resources, see Appendix Sources on page **??**.

[15] See http://www.wirelessleiden.nl

[16] However, as I describe in the concluding chapter, not everything is publicly accessible. The openness of Wireless Leiden included boundaries as well.

[17] In doing this I was inspired by the work of Kennedy (2003) and Henwood et al. (2001) who introduced the term and approach of 'technobiographies' to capture the role of technological innovations in people's lives and the different techno-social relationships which emerge as a result. The techno-biographical elements consist of only slightly edited versions of the stories of the people I interviewed in which I tried to stay as close to their actual words as possible.

The overall design of this PhD thesis is the following. Chapter 2 (Alignment work) focuses on the work involved in creating alliances and building connections between the heterogeneous elements of the network of Wireless Leiden. I describe how a new technology with the name Wi-fi evolved into a mature local network by the skillful tactics of bringing together the right actors in order to solve the main challenges for creating the network. Chapter 3 (Domestication work) analyses the work involved in extending the local network to new places, particularly the residences of home users. I describe what happens when other kind of users than lead users become part of the hybrid collective. Chapter 4 (Care work) addresses the work required in taking care of maintenance, repair and redesign of this hybrid collective. It describes how affective associations between human and non-human actors are crucial drivers for routine care work and how care work in the form of maintenance and repair involved creative redesign of artifacts. Chapter 5 (Coordination work) focuses on the work involved in sustaining the network by aligning different values of technology practices involved in innovation by user collectives. In dealing with value-conflicts two different styles of coordination work can be distinguished: a decentered and a centralized approach. Chapter 6 (Conclusion), finally, evaluates what we have learned from this study of a particular case for rethinking innovation in general.

Chapter 2

Alignment work

> "When we dream alone, it is only a dream. When we dream together, it is no longer a dream but the beginning of reality." Brazilian proverb quoted in Denning (2001).

> "Like distant islands sundered by the sea,
> we had no sense of one community.
> We lived and worked apart and rarely knew
> that others searched with us for knowledge, too ...
> But, could these new resources not be shared?
> Let links be built; machines and men be paired!
> Let distance be no barrier! They set
> that goal: design and build the ARPANET!" Cerf (1990, 202)

2.1 Introduction

Innovation by user-collectives is a well-known and frequent phenomenon in the domain of software development, but not in the domain of telecommunication infrastructures. Development of this physical layer is dominated by governments and corporations. Public-private partnerships finance, design, build, and regulate expensive and extensive information and communication infrastructures. Nonetheless, the dream of an 'ether' commons offering free access for all, has inspired Wi-Fi users to challenge corporate and governmental powers by assembling wireless infrastructures themselves locally. Leiden, a small city in the Netherlands, offers an example of how Wi-Fi users successfully created a city-wide, free wireless infrastructure.

This first empirical chapter aims to describe and understand the dynamics of the rise and growth of this local initiative by focusing on various forms of *alignment work*. As introduced in the previous chapter, I understand innovations by collectives of users as socio-technical networks, conceptualized as hybrid collectives of multiple relations and heterogeneous actors, human as well as non-human. The central question in this chapter is: How are such heteroge-

neous networks assembled? Or, reformulated in terms of work: What type of alignment work is involved in creating alliances and building connections between the human and non-human actors resulting in the hybrid Leiden Wi-Fi collective?

My argument unfolds in the following manner. Section 2.2 elaborates on the theoretical perspective for analyzing different types of alignment work by heterogeneous actors. I offer a two-part description of the rise and development of Wireless Leiden. Section 2.3 describes the socio-cultural negotiations that shaped Wi-Fi in the period when Wireless Leiden was being initiated. During this phase, lead users, their innovative agency are center-stage. By creating novel alliances between heterogeneous material actors these lead users re-engineered Wi-Fi as outdoor technology. Section 2.4 addresses processes of growth and stabilization of the wireless infrastructure as process of collective action of an innovation community. I explore the role of shared visions, technical competencies, and managerial competencies within the community and their impact on the actual shaping of Wireless Leiden as a city-wide, free wireless infrastructure. Finally, section 2.5 addresses the question whether the conceptual vocabularies of Innovation Studies and Science and Technology Studies are appropriate for describing and understanding the development of this type of user-initiated innovation in which 'community' and 'innovation' are closely intertwined. Although these theoretical approaches are helpful to analyze this case-study, I introduce the concept of *community innovation* and argue the need for adding this notion to vocabularies for theorizing innovation. Only then it is possible to capture the full dynamics of innovation initiated and shaped by user collectives.

2.2 Theoretical framework

As described in chapter 1, this PhD-thesis builds on the strands of user-oriented research within Innovation Studies as well as Science and Technology Studies. Both strands developed relevant concepts for understanding the phenomenon of innovation by non-profit user collectives. I argued that each strand is limited in a specific way, that combining the insights from both strands may very well enrich each other, and provide a more comprehensive conceptual framework for understanding the wide spectrum of work involved in creating innovations by user collectives.

In the early development of innovating by user collectives, it is likely that most alignment work is performed by individual users. If anything, user collectives are the result of alignment work enacted by individuals rather than its initial source. Thus, I expect *lead users* (von Hippel, 1986) with their knowledge and expertise of novel technologies to be central for describing and understanding the initial alignment work involved in initiating user collectives. However, as I conceptualized innovations by collectives of users as hybrid collectives, I argue as well for the need for of enriching the lead user concept originating in Innovation Studies, with notions of *user diversity* Oudshoorn and Pinch (2003b)

and *script* Akrich (1992) granting agency to material actors, originating in Science and Technology Studies.

Once the initial alignment work has resulted in the birth of a viable hybrid collective, it is important to analyze the subsequent alignment work aimed at transforming the newborn into a mature, robust heterogeneous network. For understanding processes of growth, I argue that it is fruitful to combine the Innovation Studies notion of *innovation community* (von Hippel, 2005a) with the Science and Technology Studies notion of *heterogeneous engineering* (Law, 1987).

2.2.1 Alignment work by users: lead user, diversity and script

As described in chapter 1 (Innovation by communities), von Hippel introduced the concept of *lead user*. This notion referred to users who "face needs that will be general in a marketplace — but face them months or years before the bulk of that marketplace encounters them" (von Hippel, 1986, 796). These users are positioned "to benefit significantly by obtaining a solution to those needs" (ibidem). Lead users can — but need not — invent, design, and build their own solutions to suit their needs. Since lead users are aware of future market needs, they potentially serve as an excellent "need-forecasting laboratory for marketing research" (von Hippel, 1986, 791). By emphasizing lead users as a rich resource for corporate innovation, von Hippel (1988) elaborated a methodology for marketing departments to identify lead users as representing needs of future markets. Thus lead users could possibly play a major role in the design of prototypes of new products.

In his later work von Hippel proposed an institutional forum where users and producers meet (von Hippel and Katz, 2002). Various Science and Technology Studies scholars similarly stressed the relevance of such institutional loci — referred to as *nexus* (Schot, 1992) or *mediation junction* Schot and Albert de la Bruheze (2003) — that enhance the interrelationship of design and use. Institutional loci are considered important places for social learning processes in which alignment in articulation processes between various actors from both contexts can be established (Rip et al., 1995; Stewart and Williams, 2005). In this area the concerns of Innovation Studies and Science and Technology Studies appear to intersect, but there are differences as well. Whereas von Hippel has mainly focused on interaction with lead users, as those who represent future market needs, user-oriented Science and Technology Studies scholars have advocated the need to be sensitive to the diversity of users, who potentially have quite different needs and agendas (e.g. Oudshoorn et al. 2005; Hyysalo 2007). Within Science and Technology Studies diversity is often articulated along demographic lines (age, gender, class) or in terms of different positions (management, end-users, non-users). Although von Hippel has paid less attention to such types of user diversity, I credit his work for highlighting lead users as a specific group of users — one that did not arise from the general heuristic of diversity as mobilized within Science and Technology Studies.[1]

[1] Recent Innovation Studies literature have explored the diversity and dynamics of roles participants

A second concept from the Science and Technology Studies vocabulary valuable for analyzing user innovations is *script*. This concept explicitly relates artifacts and their practices of use by suggesting that all designers base their products on envisioned users and specific use situations (Akrich, 1992). Accordingly, products contain a script, which is the materialized presentation of envisioned use. The use of a product is described in semiotic terms as 'reading' its script. In this reading — which essentially involves adapting novel products to established user environments — meanings, uses, or even products themselves can be changed and adapted. Users may interpret scripts in ways that differ from those of designers. Lead users, in this conceptualization, constitute a specific group of users that adopt specific, informed ways of not just reading but also 're-interpreting' and 'rewriting' scripts, by inscribing characteristics of their specific use situation into products. In many cases this even involves changes in the material design of products in addition to their symbolic meanings.

Central to the script approach is the symmetrical analysis of interaction between user and artifact. Both users and artifacts can be analyzed as attributed with (inscribed) agency and meaning that enable and constrain practices of use and agency of users. Both user and artifact shape and at the same time are shaped by use practices. From a Science and Technology Studies perspective, agency of lead users and their re-interpretations are analyzed in direct relation to the inscribed agency and meanings (scripts) in the artifacts they use and produce. In this case-study, then, I take the agency of artifact itself as a category of analysis — a focus that is absent in Innovation Studies — and argue its relevance for understanding the dynamics of where and how lead users and their activities come into being.

Enriching the notion of lead users by attending to user diversity and material agency is fruitful when it comes to analyzing the various forms of alignment work between human and non-human actors involved in the early periods of bottom-up innovation by user collectives.

2.2.2 Alignment work in user communities: innovation community and heterogeneous engineering

As described in chapter 1 (Innovation by communities), von Hippel introduced the concept *innovation community* to refer to organized cooperation in developing, testing and diffusing user-initiated innovations (von Hippel, 2005a, 96). Although von Hippel defined the innovation community concept very broadly, he mainly addressed and analyzed it as a locus for exchanging innovative ideas and information among involved *individual* community members.

In this chapter I argue that the innovation community concept is not adequate to capture the full dynamics of innovation by user collectives. I argue that

can play in innovation communities. In this regard von Krogh et al. (2003) have studied how newcomers' identities in an open source community evolved into those of accepted members; Shah and Tripsas (2004) explored user entrepreneurship by focusing on user innovators starting their own firms; and Hienerth (2006) described the dynamics of user innovation communities evolving into commercial and manufacturing communities after the commercialization process of user innovations through the pioneering activities of user manufacturers.

the activities of innovative user collectives involve alignment work — aimed at creating and sustaining stable networks — which goes beyond an exchange consisting exclusively of ideas and information.

To investigate alignment work involved in building and sustaining the hybrid collective of Wireless Leiden, I mobilize the concept of *heterogeneous engineering* (Law, 1987, 1991). Heterogeneous engineers not only create and align technological elements, they also bring various types of political, economic and cultural elements into line with scientific and technological elements, "inextricably bound up into an organic whole" (Callon, 1987, 84). Heterogeneous engineers continuously perform various types of work to align both technical and social elements into an actor-network so as to build stable coalitions that are necessary for the successful development and implementation of innovative technologies. Similarly, in innovation by user collectives, users are enacting such heterogeneous engineering when bringing into line various elements which are necessary for the development and stabilization of both the innovation community and the community innovation itself (which also constitutes the community). This is why I rely on the perspective of heterogeneous engineering for analyzing the innovative agency of communities by addressing the heterogeneity of alignment work in innovation communities.[2] Sensitized by scholars putting invisible work (Star and Strauss, 1999; Shapin, 1989) on the research agenda, I myself seek to move beyond an exclusive focus on core actors within innovation communities by rendering visible the role of community members who perform non-entrepreneurial activities by taking care of human and non-human actors constituting the hybrid collectives of community innovation.

After elaborating the theoretical concepts for understanding the various types of alignment work, I now return to the case-study of the Wireless Leiden collective.

2.3 The rise of Wireless Leiden as user innovation

In this section I analyze the dynamics of the rise of the user community that created Wireless Leiden. In describing these dynamics, I focus on identifying lead users of Wi-Fi technology and the types of work they performed to align human and non-human actors into a novel network as the basis for Wireless Leiden community. To understand the character and the type of work lead users had to perform to align the Wi-Fi technology with their aims, we need insight into the script — the materialized prescribed use — of Wi-Fi itself. Therefore, I start with a brief historical description of Wi-Fi itself to illustrate how it was constructed with specific uses in mind, thus resulting in a script enabling and constraining practices of later Wi-Fi lead users not previously envisioned by designers and regulators.

[2] Truffer and Dürrenberger (1997) address the relevance of heterogeneity by emphasizing the role of 'outsiders' in creating 'innovative milieus'.

2.3.1 The shaping of Wi-Fi as indoor local area technology

The emergence of Wi-Fi started when the American regulatory agency Federal Communication Commission (FCC) in 1985 decided to allow the use of spread spectrum, a special radio technique, in an unlicensed part of the ether (Federal Communications Commission, 1985).[3] The availability of spread spectrum radio technology within the United States, where it previously had been restricted to military use, opened up the possibility for the creation of wireless local area networking by actors without large financial resources. By opening the free industrial, scientific and medical (ISM) radio bands — no (expensive) licenses were needed — for spread spectrum modulation, the FCC deliberately created a niche for experimentation with novel uses. At the same time, however, the FCC restricted potential use of this part of the ether by limiting the maximum power of the wireless devices and by prescribing small antennas to prevent interference as much as possible. The FCC explicitly envisioned only indoor use of this wireless technology as an alternative to indoor cabling.[4] This envisioned indoor-only use materialized into devices that came on the market based on the IEEE standard 802.11 (IEEE, 1999), within the free ether parts offered by the FCC.[5] In 1999 computer producer Apple brought Wi-Fi to the masses by selling an inexpensive Wi-Fi card below the hundred US dollar consumer market threshold.

The intended indoor use of Wi-Fi in offices, homes, shopping malls, or airports was as firmly inscribed into artifacts as in mandatory regulations. Signals from standardized Wi-Fi equipment only traveled a maximum of hundred meters due to legally enforced power restrictions. The allowed 100 milliwatts maximally allowed emission level of Wi-Fi devices was a mere one-tenth of mobile phones. Furthermore, Wi-Fi devices were equipped with small, fixed and often integrated antennas with a limited range. The commercial interest of big players in the Information and communication Technology market was also embedded into the design of the standardized Wi-Fi devices as they could only function in combination with commercial operating systems from Microsoft and Apple. Consumers wishing to use their wireless equipment with open-source operating systems such as Linux or FreeBSD were left in the cold, in quite the same manner as those 'allergic to onions' served by the restricted and standardized menu in a MacDonald's fast food restaurant.[6]

Evidently, the standardized Wi-Fi equipment had a clear indoor-use-only script that imposed rather forceful restrictions on ways in which these devices could be used, especially restricting outdoor use. However, Wi-Fi devices not only intentionally constrained use practices, but invited and enabled new ones

[3] When I started my research the tale of the history of Wi-Fi still had to be written. Therefore, this section is based on the 'oral history' as told by Vic Hayes, former chair of the 802.11 working group, 2005-12-19. In the meanwhile a book on 'the genesis of Wi-Fi' is forthcoming, edited by Hayes and Lemstra (2010).

[4] Office of Engineering and Technology, Federal Communications Commission (1993). Understanding the FCC Regulations for Low-power, Non-licensed Transmitters, p. 2. Available online.

[5] Also see the IEEE 802.11 Working Group Timelines, available online.

[6] See Star (1991b).

as well, although unintentionally.[7] Some groups of users saw the potential of Wi-Fi technologies for solving practical problems of providing cheap broadband Internet to rural areas and remote villages not catered by commercial providers. Other users were driven by the vision of utilizing Wi-Fi for the creation of so-called wireless Free-nets. In their view Wi-Fi technologies could enable community wireless networks free from governmental and corporate restraints. Wireless Leiden is one such initiative. The type of work that had to be performed by these users to align the Wi-Fi technology with their vision of establishing free wireless communication networks was influenced by the existing indoor-use-only script. Therefore, the first steps toward constructing a grassroots Leiden wireless network involved the re-engineering of the script of commercially available Wi-Fi technologies.

2.3.2 Reshaping Wi-Fi as outdoor wide area technology

The first ideas about a wireless community network in Leiden can be traced back to 2001 when a Leiden resident, Jasper Koolhaas, encountered Wi-Fi for the first time. Koolhaas, trained as an electrical technical engineer and fascinated by computer technology, saw the potential of Wi-Fi technology for creating a free wireless infrastructure. Later Koolhaas recounted this 'Eureka' moment about outdoor Wi-Fi:

> "When thinking about this [Wi-Fi] a bit longer, at one point I suddenly thought: Holy smoke, this is not just interesting — this is earth-shaking. For the first time in history ordinary people, like you and me, can build a wireless communication infrastructure themselves. Until then this was restricted to governments or big companies... Admittedly, radio amateurs were already doing the same for some time, but those infrastructures were only accessible for licensed amateur radio operators. And Wi-Fi is in an unlicensed band, free to use for all."[8]

Clearly, the script of the standardized Wi-Fi devices had both enabling and constraining features for users. Wi-Fi enabled a shared vision of a new, cheap, and free infrastructure. Nonetheless, connections were still constrained by distance, interference and maximum allowed power levels. What type of work was needed to re-engineer the inscribed script?

[7] Winner (1980) argued that the 'politics of artifacts' are usually not the result of an intentionally 'evil plot'. For instance he mentioned how architects' neglanctance could unintentionally exclude people in wheelchairs from entering a building with a staircase at the entrance without additional help (at least as long as there is no additional ramp). Akrich (1995) argued how the so-called 'I-methodology' in which designers model user representations after themselves often is the source of neglecting needs of types of users with characteristics different from the designers. In the case of Wi-Fi its standardization effort was led by professional technicians from large corporations, prioritizing different interests than actors interested in Free-nets. Finally, Mackenzie (2005) offered a convincing analysis of the tensions between the two different interpretations of Wi-Fi as 'cable-replacing' technology and as 'Free-net' technology.

[8] Interview Jasper Koolhaas, 2005-10-25.

By introducing himself to a local network of computer hobbyists, Koolhaas managed to interest new motivated participants in his project. One among them was Marten Vijn, at that time experimenting with the open-source operating system Linux. In the autumn of 2001 Koolhaas,Vijn and some others jointly started to experiment with Wi-Fi aiming to achieve long distance connections. In doing so, they performed various types of work to deconstruct the inscribed script in regular Wi-Fi devices. To give an idea of the complexity of the work involved: these initiators were patching firmware, writing, and adapting device drivers for Linux; they had to find solutions for increasing the range of the radio waves without increasing the output power, as this was restricted legally; they were experimenting with different types of antennas; and they had to make the devices weatherproof for outdoor use.[9] It turned out to be an especially difficult task to get the weak radio waves working in the Wi-Fi collective as they envisioned. The small group of Wireless Leiden initiators tried to find solutions in using other types of antennas.[10] Increasing output power was not an option as this would break the formal regulations and imply an illegal wireless network, risking fines and confiscation of hardware by the regulatory agency 'Agentschap Telecom', responsible for supervising the Dutch radio spectrum. Despite all their efforts and knowledge of computers and computer networks, at first the initiators failed to connect distant nodes by the Wi-Fi waves with a will of their own.

It took the experiences and knowledge of two Leiden radio amateurs to master the Wi-Fi waves. These two amateur radio hobbyists brought in a good working and cheap antenna design, the so-called quad antenna, developed decades ago by a fellow radio amateur.[11] The modified quad-antenna design making it suitable for Wi-Fi use, was called a 'bi-quad', and improved the behavior of the radio waves significantly. Bi-quad antennas could be constructed cheaply and simply as well, as they consisted of only a few parts only. Only requiring 'line-of-sight' this antenna could easily and reliably connect nodes multiple kilometers apart from each other.[12]

Now that re-engineering the range of Wi-Fi had succeeded, the indoor part of the script of Wi-Fi devices still had to be re-written by inventing a design suitable for outdoor use. The bi-quad antenna itself was weatherproof, but the cheap plastic casings of commercially sold Wi-Fi devices certainly were not resistant to rain or ultraviolet radiation. In principle, one could connect an outdoor antenna to the indoor electronic parts by using a long cable, but in practice this often reduced the quality of the signal dramatically. Therefore, the Wireless Leiden initiators chose to develop a new 'integrated' outdoor device and thus had to find ways to protect the delicate electronics against rain and wind.

[9] For an overview of all interviews, see Empirical sources on page **??**.

[10] Vaughan (1986) was the inspiration for the notion of initiators, although she mobilizes this notion in the domain of intimate interpersonal relationships to describe the process of 'uncoupling' connections, I am interested in process of creating connection in the domain of intimate interactions in hybrid collectives.

[11] American radio amateur Clarence Moore invented the quad antenna. In 1951 he was granted US patent US2537191 for his invention.

[12] Interview Evert Verduin, 2006-03-27.

Simple and cheap objects like drainpipes and plastic lunchboxes were used to house both antenna and electronics. Using home-built outdoor Wi-Fi nodes, the first data packet of the Wireless Leiden group was successfully transmitted in January 2002. In the following months additional nodes were added, resulting in a rudimentary wireless network structure that basically fulfilled the same functionality as the wired backbone of networks that are part of the Internet.

The group of Leiden Wi-Fi initiators successfully re-engineered the existing Wi-Fi devices from short-range indoor devices into long-distance outdoor devices. The dream of a free infrastructure for Leiden residents, which Jasper Koolhaas had articulated only some months before, had now become real because of the successful re-engineering activities of the cooperative collective. Now that they had translated the promise of Wi-Fi into a material reality, the the initiators decided to establish it is a legal entity as well. In August 2002 the small group of initiators established a formal not-for-profit foundation with the Wireless Leiden with some of them functioning as its board members. The officially defined main aim was the further growth and development of the Wireless Leiden collective infrastructure in order to provide Leiden inhabitants and organizations free wireless access for all.

2.3.3 User-initiated innovation as collective re-engineering

This long-distance outdoor Wi-Fi device can be characterized as innovation by lead users. Certain users (in this case located in Leiden) envisioned a new type of use based on user needs which were not anticipated by producers of Wi-Fi; and these users were to benefit from solutions to that need as well. The dynamics of this process of innovation by lead users can be characterized in two ways. First, these users actively resisted an explicit inscribed script of an existing device. This script itself defined the type of work that needed to be done before the re-engineering of this script was successful. And second, this re-engineering was a collective activity. The exchange of information and knowledge was not only essential in realizing this lead users' innovation, but also the alignment of different types of knowledge. In this case, combining the knowledge of three different domains — computer networks, open source software and radio waves — proved crucial. These different types of knowledge were distributed over more than one person.

The actors in Wireless Leiden had quite different backgrounds. Pooling their diverse interests, expertise, resources, and contacts enabled them to collectively engineer a wireless network configuration that worked. Although literature on users as sources of innovation conveys the image of the 'professional amateur' (Leadbeater and Miller, 2004), most engaged in the project were professionally employed in the ICT domain with careers related to the many puzzles that needed to be solved. For instance, professional network infrastructure builders both in the field of wired and wireless topologies were involved, as well as actors with experience relating to organization structures, programming of embedded devices, open source software development consultancy, or writing complicated routing software.

In a user-initiated innovation in which the needed expertise and knowledge is distributed across various actors, it is likely that one or a small group of them fulfills an explicit coordinating role. In the Wireless Leiden case, the initiators, such as Jasper Koolhaas and Marten Vijn, in this process took on the role of lead users; they aligned and coordinated both human and non-human actors required for realizing the re-engineering of Wi-Fi.

A second finding from this case is that lead user innovations can be understood as the result of a socio-material process in which the actual shape is negotiated among the actors and the envisioned user and use situation are configured (Woolgar, 1991). Koolhaas translated his ideal of a Free-net — a free and cheap wireless network available for everybody — into requirements that had to fit the needs of actors located in Leiden as users of the wireless network. This led to (re-)design choices that were in line with legality, low costs, reliability and usability. Interestingly, the two radio amateurs who joined the Wireless Leiden project later, had already previously in 1999 established a long-distance wireless connection of nine kilometers between their respective homes for sharing broadband Internet. For this connection they had employed 'HomeRF', an alternative wireless local area network standard, that failed to create the wide industry support which would make Wi-Fi a commercial success. Also, for their connection the two imported an expensive professional hi-gain antenna from abroad. Because they acted on their purely personal needs the radio amateurs had no incentive to share their solution. Only through active efforts on the part of Koolhaas, who serendipitously found out about their home-brew wireless connection and his active efforts in interesting the two to join in as well in the collective wireless endeavor, they became involved in the Wireless Leiden initiative. This is a nice example of what von Hippel (1994) termed 'sticky information' which is only available locally or individually. Because the ideals of the Wireless Leiden initiators were public-oriented, from the outset the Wireless Leiden initiative relied on the openness and accessibility of their information and knowledge as a central organizing principle. Translating the 'open source' value of sharing knowledge into technology, they installed a wiki — a website accessible for reading and writing by anyone — as a way to collect and communicate all information about their project and actively involve new participants. Later Wireless Leiden would be extended with a digital repository server to facilitate sharing of software code and digital documents.[13]

2.4 The growth of Wireless Leiden as community-based innovation

When the collective re-engineering of the existing Wi-Fi technology was realized, the newly established association faced the challenge of putting this wireless network into use, to expand it and increase its number of users. Building a freely accessible wireless network for general public use and organizing both

[13] Due to increasing 'link spam' the wiki was closed off for unregistered users. A subversion server was installed to take over its role for sharing information. Interview Jasper Koolhaas, 2005-10-25.

the growth and stabilization of a city-wide structure with only volunteers as human resources seemed a challenging task. Sustaining a large-scale system involved lots of maintenance, repair and redesign activities, whereas hiring employees for routine tasks was no option for this volunteer initiative with scarce financial resources.

Surely, this challenge was taken up by the initiators enthusiastically. Whereas by the middle of 2002 the newly established Wireless Leiden association had a rudimentary wireless network in place consisting of four nodes and a dozen of involved users, by the end of 2004 the network was extended to over fifty wireless nodes (covering approximately downtown Leiden), while dozens volunteers performed various kinds of tasks and over thousand local residents had connected to the wireless network for activities such as web browsing, file sharing, chatting, gaming, and making Voice-over-IP phone calls.

In this section I unravel the type of work and activities required to establish, extend, and stabilize such a wireless network. If one may understand the earlier development as a collective process of re-engineering an existing technology by a group of lead users, the further development of Wireless Leiden I analyze as community-based innovation. I elaborate the concept of innovation community put forward by von Hippel — who actually focused on the role of information exchange — by addressing the variety and heterogeneity of activities performed in such a community.

2.4.1 Aligning new actors, shaping heterogeneous user roles

In order to realize further growth of Wireless Leiden, both wireless infrastructure and user base were developed simultaneously; the one could not evolve without the other. Managing this co-evolutionary development of material infrastructure together with 'social' community organization required strenuous alignment work. In this process of aligning various material and human actors, different types of user roles were constructed and various kinds of work and responsibilities were distributed across these various user roles.

The organizational user as sponsor

One of the first hindrances to be tackled by the initiators, involved finding financial resources for covering the costs of new wireless nodes. Until then, they themselves as active hobbyists had paid for the necessary technology purchases. However, this was no longer viable as goal had become to realize an city-wide public infrastructure, involving many more nodes.[14] Meanwhile, a new participant had joined the initiative, Huub Schuurmans, who brought with him new knowledge and expertise that played a central role in organizing and coordinating the further growth of the wireless collective. Schuurmans had been active as a former public relations officer for the oil company Royal Dutch

[14] Wireless Leiden estimated the costs for a reliable node, consisting of two interlinks for backbone communication and one access point for local access, somewhere between 1000 and 1500 Euros. Interview Jasper Koolhaas, 2005-10-25.

Shell, and as former scientific attaché for the Ministry of Economic Affairs, establishing the Netherlands Office for Science and Technology in Silicon Valley. Through his professional career Schuurmans had become an expert in, as he put it himself, "open innovation, public relations and creating local support."[15]

Schuurmans became the driving force behind a continuous, pro-active media campaign resulting in widespread publicity for Wireless Leiden, and he arranged contacts with various Leiden organizations that might want to support the Wireless Leiden network. For instance, he asked various organizations to sponsor a node. The first official node sponsor was the local software company Cope that decided to sponsor two new nodes. In return the company Cope used the Wireless Leiden infrastructure as its own 'virtual private network' (VPN) allowing employees' safe and free access to the company network from their homes. This new approach in which organizational users doubled as sponsors provided in fact the model for integrating local companies and other donor organizations into the project's infrastructure. Sponsors would pay for new nodes, which in turn were given the sponsors' names, and, more importantly still, they became users of the wireless infrastructure as well. Wireless Leiden could offer them VPN functionality with a better price-performance ratio than any commercially available system. As Koolhaas explained:

> "This company Cope paid for two nodes and, well, in an organizational sense this was the first building block of Wireless Leiden. Earlier, the focus was on technical issues, but now it grew more into an organization because the basic idea itself became clearer: a company would fund the building of new nodes because that would serve their own needs, yet at the same time this would be helpful to other people as well. Thus this model reinforced the network's inner dynamic."[16]

After the first companies had started to pay for new nodes the Wireless Leiden organization managed to convince public organizations such as local schools and libraries to join the project as well. At one point the enthusiasm of organizations to participate as users in Wireless Leiden was so enormous that the volunteers in charge of constructing and programming the nodes could not keep up with the new requests.

The volunteer user

In 2002 the influx of Wireless Leiden enthusiasts increased sharply, while the small group of Wi-Fi initiators meanwhile evolved into a much larger group consisting of dozens of volunteers. To manage all these people, the notion of 'official Wireless Leiden volunteer' was invented. Actually this was just a way to make the existing situation explicit, whereby only registered members had access to email correspondence. There was another new element: in order to become an official volunteer, one had the sign a contract. This contract was

[15] Interview Huub Schuurmans, 2005-10-09.
[16] Interview Jasper Koolhaas, 2005-10-25.

meant to protect volunteers against liability claims pertaining to, for instance, accidents that might occur during the building of a new network node, such as people or things falling off from a rooftop. At the same time, volunteers officially waived their rights to any intellectual property claims. For this purpose, two members employed as lawyers developed a specially crafted 'Wireless Leiden License'. The legal contract was meant to prevent people from patenting novelties invented by using the Wireless Leiden network.

To coordinate all those new volunteers effectively, various subgroups were formed in which volunteers could specialize in activities tied to the Wireless Leiden project that had their particular interest, such as building nodes, maintaining the website, or writing software code. In addition, Dirk-Willem van Gullik, another Wireless Leiden volunteer and former president of the Apache software foundation, introduced the 'who-builds-decides' rule to prevent endless debates without getting anything done.[17] Over time, several formalized procedures organized the Wireless Leiden community, while the Wireless Leiden board held control over the 'interface' connecting the local Wireless Leiden network to global networks in the world 'out there'. A more detailed analysis of the work for coordinating actors with different types of interests in Wireless Leiden is presented in Chapter 5 (Coordination work).

The home user

In January 2003 Internet Service provider Demon sponsored Wireless Leiden with access to three of their ADSL Internet lines. This allowed Wireless Leiden to offer free Internet access (restricted to the 'world wide web' part of the Internet) to local residents. This new option attracted many new users and in this way Wireless Leiden configured a new type of user: the home user who wanted to associate himself of herself with Wireless Leiden to surf the web or email through a free web mail account, but who was not interested in additional services.

Wireless Leiden facilitated users who lived in the parts of Leiden that were covered. Wireless Leiden users living outside of the reach of existing Wi-Fi nodes initiated the construction of new nodes to link their neighborhood to the backbone themselves. To realize new nodes, they performed various heterogeneous activities: finding a sponsor, asking volunteers to assemble and program the node, locating suitable locations to put nodes on, and getting permission and electricity from homeowners. The board of the Wireless Leiden association organized open meetings for interested residents in order to work on creating new nodes.

[17] Within Wireless Leiden Van Gullik not only referred to his experience in coordinating the Apache project, but also actively referred to a FreeBSD hacker who wrote on expose on the question of 'why should I care what color the bike shed is?'. In the words of Kamp (1999): "The really, really short answer is that you should not. The somewhat longer answer is that just because you are capable of building a bike shed does not mean you should stop others from building one just because you do not like the color they plan to paint it. This is a metaphor indicating that you need not argue about every little feature just because you know enough to do so. Some people have commented that the amount of noise generated by a change is inversely proportional to the complexity of the change."

This new type of user, no longer needed to have either the knowledge about installing outdoor Wi-Fi or the motivation to let the overall project succeed. One of the radio amateurs, the Wireless Leiden member Johan de Stigter, sold ready-made Wi-Fi aerials, a product with commercial potential. To make it easier for home users to connect to the 'free Internet', he developed a black-boxed user solution. This made it no longer necessary to tinker with and disassemble commercial routers and soldering one's own bi-quad antenna to produce a 'drainpipe client hack'. His company Gandalf released a 250 euros plug-and-play device called Wandy (a contraption of handy and the three-letter-acronym WAN, short for Wide Area Network). This way De Stigter developed transformed the 'drain-pipe client' into a mature consumer product.[18] The Wandy kit contained everything users needed, provided they were able to receive the Wi-Fi waves in their neighborhood. His kit was available at a Leiden electronics shop that also offered additional installation assistance if needed. A more detailed analysis of the work performed by home users is presented in Chapter 3 (Domestication work).

The maintenance user

With the increasing number of nodes, volunteers, and end-users, maintenance of the network became a topic of discussion. The growing group of residential end-users implied higher expectations about the reliability of the Wireless Leiden network and its services. The number of nodes increased sharply, requiring routine maintenance work. Although there were lots of volunteers by now, most of them were only willing to try out new and "exciting" things, and were much more reluctant to perform 'routine' jobs. To solve this problem, in April 2004 the Wireless Leiden board constructed a new user role: the node-adoption-volunteer (NAV). These special volunteers were prominent users of a specific network node, and if 'their' node was functioning erratically, they were usually among the first to notice. Or a local user of a certain node who complained a few times when a node was not functioning properly was asked to become responsible for keeping an eye on a local network node. In case of a malfunctioning, the node-adoption-volunteer was supposed to check the situation, press the reset button, and test if the connection came 'up' again. If not, the whole node was disconnected and brought to one of the more experienced volunteers and exchanged for a working one. To assist the node-adoption-volunteers, more technically experienced users of Wireless Leiden produced special standardized checklist forms to assist them with on-site node failure debugging. By constructing the role of the NAV, the network builders delegated some aspects of the maintenance work to local users. A more detailed account of how users and volunteers took care of the maintenance and repair of the Wireless Leiden network is presented in Chapter 4 (Care work).

[18] The Wandy kit was not exclusively targeted to Leiden residents but to a wider market for wireless broadband Internet access solutions in remote places such as camping sites or holiday parks.

2.4.2 The innovation community as heterogeneous network

In my analysis of the alignment work involved to create and sustain the innovative user collective of Wireless Leiden, I encountered phenomena that cannot be described adequately by the theoretical framework offered by von Hippel (2005a). Particularly his concept of innovation community falls short. Where in the innovation community concept information exchange between users — that is primarily lead users — is central, the Wireless Leiden case illustrates that the innovation community members perform many more activities. More central than exchange of information is the continuous coordination of the heterogeneous resources that make up Wireless Leiden.

The growth and stabilization of the wireless infrastructure was based on constructing, aligning, tuning, and supervising these heterogeneous user groups. Skillfully organized and timed PR-activities contributed to the numerous successful alignments between various social groups and Wireless Leiden. It is in particular the heterogeneity of all these activities that contrasts with von Hippel's singular focus on the circulation of information. Furthermore, my analysis reveals that the shaping of this wireless infrastructure should take into account a wide variety of different types of users, rather than be understood in terms of lead users only. The Wireless Leiden case comprises an array of different user roles, each one of them contributing to a specific and vital element of the growth and stabilization of Wireless Leiden.

2.5 Understanding Wireless Leiden as community innovation

In this chapter I have described how a group of Leiden citizens, managed to build a mature, free city-wide Wi-Fi infrastructure by the skillful tactics of creating new alliances between heterogeneous human and non-human actors. For realizing the growth and stabilization of Wireless Leiden, the availability of a diverse set of skills and competencies proved crucial. In the early period necessary skills were primarily of technical nature, and geared toward the disciplining of radio waves, or mastering complicated routing puzzles in complicated software. In the following period of growth and stabilization, managerial, organizational, public relations and juridical skills helped to solve many puzzles.

Not only did my analysis of the rise and growth of Wireless Leiden show the relevance of diversity of actors, heterogeneity of types of work, an even more important insight is the intrinsic hybrid character of Wireless Leiden. The social and the technical elements are inextricably interwoven; the innovation community is part of the innovation itself. Both the wireless infrastructure (the innovation) and the organization structure (the community) developed in mutually interconnected ways. In a similar fashion as Hughes (1983) described how Edison had built 'networks of power' to bring 'electricity' into the homes of American people; the initiators of the Wireless Leiden collective had built 'networks of support' to bring 'wireless' into the homes of Leiden inhabitants.

The entanglement of Wireless Leiden as infrastructure and as community is visible in the way a single node of the wireless network functions. It is a hybrid entity of technical elements (such as antennas, cables, software, Wi-Fi devices, the roof) *and* human elements (for instance sponsors, builders, node adoption volunteers, the roof-top owner). Without any of these elements, a Wireless Leiden node could not function or exist at all.

Von Hippel and Innovation Studies scholars involved in extending his ideas, have primarily conceptualized innovation communities as the origins of technical innovations. Although this approach has been productive, this conceptualization of innovation community does not allow for describing user-initiated innovation processes where the social community and the technical innovation evolve mutually and are inextricably bound up with each other. Or, formulated alternatively, it is inadequate to assume an a priori distinction between the 'technical' innovation and the 'social' community, let alone a causal relationship. My analysis of the alignment work involved in the rise and growth of Wireless Leiden shows that its development can only be understood as a process of co-evolution of both the technical infrastructure and the social community.

For this reason, I propose the concept of *community innovation* as a way to conceptualize the type of user-initiated innovations whereby the community itself is an essential element of the innovation. This concept makes it possible to understand the specific dynamics of these types of user-initiated innovations, and I would like to single out three of its advantages in particular. First, the concept allows me to analyze growth and stabilization of the innovation as the result of the activities of a community of actors who are users and producers simultaneously. For many of the actors involved it is precisely the expertise originating in this double role of creating as well as using an innovation that fuels their active involvement. Von Hippel (2005a) also addressed this phenomenon for explaining lead users' activities. In contrast, the concept of community innovation draws attention to the diversity of competency and expertise of multiple users necessary for dealing with dynamics of growth and stabilization.

Second, the concept of community innovation foregrounds work by heterogeneous collectives, most notably coordination and alignment work for managing the various actors involved in the hybrid collective. In the case of Wireless Leiden, this coordination was predominantly performed by a core group of approximately eight to ten community members. For the understanding of the dynamics of growth, stabilization, and the actual shape of Wireless Leiden as community innovation, the characteristics of this core group, most notably their skills in engineering the 'technical' and the 'social' simultaneously, seemed central. The composition, the shared vision, the range of competencies, and the knowledge distributed across the core group; all these factors have greatly influenced the actual shape of Wireless Leiden as free and open-source wireless infrastructure.[19]

A third benefit of the community innovation concept is that it portrays inno-

[19] During the early history of Wireless Leiden it was globally unique compared with similar community Wi-Fi collectives of that time in terms of wireless backbone design, number of nodes, number of active volunteers and diversity in types of users.

vation enacted within, by and as hybrid collective: an evolving socio-technical network in which both human and non-human actors are active and become aligned. Innovation in the case of the Wireless Leiden collective can be studied as the construction of a socio-technical chimera, built from a variety of different elements: all kinds of different people, email clients, websites, ideals about freedom, dreams about huge free infrastructure networks, unlicensed ether bands, cheap consumer-grade Wi-Fi devices, computers, antennas, TV satellite dishes, laws and regulations about Wi-Fi use, and international standards. The 'social' characteristics of the innovation community and the type of knowledge and expertise available in the network on the one hand, and the 'technological' material aspects on the other hand, evolve in a process of mutual shaping.

As my argument demonstrated, the notion of community innovation can develop into a relevant conceptual tool to increase understanding of current and future tendencies in an emerging civil society in which ordinary citizens become more and more actively involved in shaping their technical and social environment. Wi-Fi as successful implementation of the 'dream' of a free access ether commons, inspired users in Leiden to develop their own wireless infrastructure. Doing so these actors collectively redefined the identities of Wi-Fi, Leiden and that of non-paid professional Wi-Fi volunteers all at the same time. In short this collective effort established a true innovation by giving birth to new entities that changed the world irreversibly, at least locally. Other well-known examples of innovation by user collectives, such as the free online encyclopedia Wikipedia and the open-source operating system Linux, are encountered by millions of users in everyday life. The relevance of current and future innovation by user collectives is emphasized by innovation 'gurus' such as Charles Leadbeater (Leadbeater and Miller, 2004; Leadbeater, 2008; von Hippel, 2005a). And, last but not least, Eric von Hippel, suggested that innovation by users will be key for 'democratizing innovation' in the twenty-first-century von Hippel 2005a.

Clearly the concept of community innovation needs further study and elaboration. One way is to study the rise and growth of other cases of community innovation. However, this PhD thesis follows another route by zooming in further into the case of the Wireless Leiden collective. This enables me to study into further detail the different types of actors and their work involved in the ongoing building and sustaining of Wireless Leiden as case of community innovation. This route allows me to increase understanding of innovation by user collectives, and to further develop the notion of community innovation.

Chapter 3

Domestication work

> "The savvy writer will remember that when it comes to technology, even those bright and eager engineers who develop it aren't really experts on how their technology will be used." Van (1997, 209)

3.1 Introduction

3.1.1 Following home users

In the previous chapter the focus was on the heterogeneous engineering work of a small group of enthusiasts assembling a locally entrenched hybrid collective they officially named "Wireless Leiden". After this group had been able to translate indoor Wi-Fi equipment, open source software, computer hobbyists, radio amateurs and local businesses into actors supporting a local wireless computer network, one of the latest actors to interest into "Wireless Leiden" were local inhabitants. Through the translation of Wireless Leiden from generic wireless infrastructure into "free Internet", in the beginning of 2003 a specific type of actor emerged: the home user.

Choosing the term home user to refer to this actor group is a deliberate choice, based on a motivated dislike for the often used phrase 'end user'.[1] In the first place, this term often arouses pejorative associations of users as people lacking skills and knowledge to operate certain devices. Secondly, the term end user implies that users are located at the end of the innovation process, only needing to accept a new technology by buying it. What happens when people

[1] Another alternative term for end users that often appears in research literature is 'residential user'. I have deliberately chosen the term home user instead of residential user. In the case of Wireless Leiden, use practices located in the home are inextricably tied to the materiality of the house as building. As devices to connect to Wireless Leiden are installed onto and into the home, they become part of the home itself. Only homes translated in such way can enable home users to connect themselves to the Wireless Leiden collective. In terms of the work of Donna Haraway (1991), one could conceive a home user as a temporarily immutable cyborg, a chimera consisting of home, inhabitant, Wi-Fi devices, and invisible electromagnetical waves; enacted during practices aimed at connecting with Wireless Leiden in order to use Internet.

take their acquisition home to actually use it, is often of little concern to those utilizing the label end user. While dominant discourse often labels non-expert users as 'end users' I do not think this term appropriate when applied in relation to community innovation because in community innovation users are actively involved in the innovation process, and certainly no passive recipients. Another similar term I choose not to employ, is 'lay end user'. This notion was introduced by feminist sociologists (Saetnan, 2000, 16) to highlight the relative exclusion of some end users from expert discourse. Often the 'knowledgeable' experts regard lay persons as being unqualified to enter discussions and additionally being a nuisance or 'waste of time' to deal with.[2] However, in the case of Wireless Leiden, people interested in its use at home, are not looked down upon, but actively being enlisted into the community. So to conclude: by focusing on the location of use first, in my view the phrase home user is the most appropriate.[3]

In this chapter we pick up the thread of the dynamics of community innovation by following actors interested in using Wireless Leiden at home. The previous chapter ended with an overview of different types of users: the volunteer user, the organizational user, the sponsor user, the user-entrepreneur, and the home user. Based on the decision to study Wireless Leiden home use practices, this chapter aggravates on following home users. Only where other user types interface with home users, their actions are followed as well. Doing so, the focus of this chapter shifts away from the "makers" of community innovation to refocus again on the "users" of Wireless Leiden as example of community innovation. The central claim of this chapter is that innovation work does not end once the network is up and running. As we will see, the activity of getting a domestic environment and Wireless Leiden connected together is neither straightforward nor obvious. Quite to the contrary, strenuous labor is involved; without any guarantee for success whatsoever. Before turning to the empirical data, a short detour through theory provides the concepts to analyze the journey of an innovation from community of makers to users' homes, becoming part of everyday life.

3.1.2 The domestication approach

The theoretical topic of this chapter can be summarized in one sentence by the following quote by Callon (2004, 3): "Adopting an innovation means adapting

[2] An example of this hostile attitude towards end-users is observed by Clarke and Star (2008). The Dutch computer scientist Edsgar Dijkstra already in 1982 aptly described the pejorative connotations built into the term 'user': "The computer 'user' isn't a real person of flesh and blood, with passions and brains, no, he is a mythical figure, and not a very pleasant one either. A kind of mongrel with money but without taste, an ugly caricature that is very uninspiring to work for. He is, as a matter of fact, such an uninspiring idiot that his stupidity alone is a sufficient explanation for the ugliness of most computer systems. And oh! Is he uneducated!" (Dijkstra, 1982, 1-2)

[3] Finally, as the service to connect to limited parts of the Internet through Wireless Leiden is neither considered as a core part of the collective, nor does it require a paid subscription or registration, I do not deem the term 'consumer' appropriate for describing the actor type I termed home users. Restricting the analysis of the activities of home users to the single act of buying the hardware devices, or the 'technology acceptance' of Wi-Fi, in order to connect to Wireless Leiden would constrain an understanding of the full range of activities and work involved severely.

it." In this case, however, the innovation is a special type, namely community innovation. The work of adapting it to fit it into peoples homes and everyday life is distributed over many different actors. This act of 'adapting it' is a process requiring work. Hence adaptation work is a sub-set of the over-arching notion of innovation work. Already in the first chapter we saw how users — in the form of hackers, explorers, hobbyist, enthusiasts — adapted Wi-Fi technology to accommodate its envisioned new use practices. However, in this chapter we focus on another type of adaptation work, namely adapting community innovation to enable its use in everyday life. The main difference in focus between this chapter and the previous one, is that in this chapter we follow a different actor-type, namely actors who are lacking a high level of technical competency in the domain of computing, networking and wireless technologies. Additionally, in this chapter we focus on the instrumental use of community innovation, and not its creation as a goal in itself. To create a clear distinction between the adaption work described in this chapter, and the previous one, adaption as "translation-to-the-home"[4] is labeled *domestication work*. The remainder of this section is devoted to the introduction of the domestication approach, a concise summary of its application in current research. The domestication approach functions as a heuristic device for analyzing empirical data concerning use practices of Wireless Leiden in everyday life.

As we will see both the 'adapting' as well as the 'adopting' is a two-way process in which both actors-turned-into-users as well as community-innovation-turned-into-something-usable both are changed and changing. Or summarized in the vocabulary of the material-semiotic approach: translation is always a two-way process.

One of the strengths of the material semiotic approach, namely conceptualizing the process studied by ways of an 'infra-language'[5] which enables the researcher not getting trapped into a priori dichotomies, for example between user and producer, at the same time is also a weakness. Although for the researcher everything might still be at stake, and categories and technologies might be fluid, from the perspective of the actors themselves, things might look quite differently. Most 'lay end users' for example feel unable to open up the black box of technology, and seen from their experience technology can behave quite deterministically (Wyatt, 2003, 2008). However, leaving black boxes closed does not mean that 'lay end users' are not endowed with agency anymore. The question thus becomes how to capture and analyze this 'active appropriation' by lay end users conceptually?

The domestication approach offers a promising conceptual vocabulary to

[4]This reference is a pun on the family of FFT(x) abbreviations commonly used in broadband policy documents, such as FTTH, FTTN, FTTC, FTTB, FTTK, FTTP, FTTE, FTTCab), is intended. Whereas a notion such as FTTH ("fiber-to-the-home") is limited to the physical linkage between technology and home environment, the notion of TTTH ("translation-to-the-home") can be understood as dealing with both the socio-technical nature of this linkage, as well as the active and dynamic process of mutual interaction between home environments and novel network technologies.

[5]On the notion infra-language see Latour (2005, 49) who stated that "analysists are allowed to possess only some infra-language whose role is simply to help them become attentive to the actors' own fully developed metalanguage, a reflexive account of what they are saying".

analyze the necessary work to successfully translate Wireless Leiden from a 'technical hobby project' into something usable within common people's homes. The term domestication itself was introduced by Roger Silverstone (Silverstone et al., 1992) to describe how the integration of innovations into daily life literally involves a "taming of the wild, and cultivation of the tame" (Silverstone and Haddon, 1996, 60). The domestication concept was introduced to approach the lacuna in research literature "addressing the innovation process as a whole" (Silverstone and Haddon, 1996, 70). The underlying strategy is to realize that "design and domestication are two sides of the same innovation coin" (Silverstone and Haddon, 1996, 46). Or to put it differently: "the necessary symbiosis of all market economies" is a dialectical relationship between production and consumption (Silverstone and Haddon, 1996, 72). Although nowhere referenced explicitly, the works of Karl Marx, already stating that "consumption is production", are sometimes literally echoed (Silverstone and Haddon, 1996, 232).[6] Framing the "user as consumer" enables a broadening of the analysis of "the user as part of a wider social, cultural, and economic environment" instead of reducing the user to an individual technical entity enacted solely in interfacing with a device (Silverstone and Haddon, 1996, 52). The starting point for the analysis therefore is not technical objects, as is common in Science and Technology Studies, but users and their use practices.

After giving users more flesh on their analytical bones by placing them in the broader arena of consumption, a second goal of the domestication approach is to provide them with additional agency as well, so they can act there on their own, instead of being pulled on as string puppets[7] by designers and producers: "users and consumers are seen to be active, not just passive, participants" of the innovation process (Silverstone and Haddon, 1996, 59).

To study the broader dynamics of innovation both its design-side as well as its domestication-side can be analytically divided into different dimensions.[8] The design-side consists of the dimensions of (1) creating the artifact; (2) creating the user; (3) catching the consumer. It is in this third dimension that the design-side interfaces with the domestication-side: "If producers ... have to 'capture' the consumer, the reverse is also true, consumers have to 'find' the technology" Silverstone and Haddon (1996, 56). The domestication-side also consists of several dimensions: (1) commodification; (2) appropriation

[6] Oudshoorn and Pinch (2007, 554) show how Karl Marx (1973[1857-61]) already noted that "the process of production is not complete until users have defined the uses, meanings, and significance of the technology", which resonates strongly with the underlying central claim of the domestication approach. As I have chosen a material-semiotic approach for analyzing community innovation, I do not develop any further inquiries into Marx' concept of commodification as part of his critical analysis of capitalism.

[7] In another section I further elaborate on this string puppet metaphor. In a more positive manner, Latour (2005) also introduces this metaphor, although his argument seems to be that the degree of freedom of string puppets is equaled by the number of connections. In this sense emancipation, according to him, means more connections, instead of less.

[8] The authors deliberately speak of dimensions instead of phases to prevent to occurrence of undesirable associations with a linear model of innovation. Also see (Sørensen et al., 2000) for a further elaboration on the choice for 'dimensions' to prevent the pitfall of thinking of innovation as a linear process.

consisting of (2a) objectification and (2b) incorporation; (3) conversion.[9]

Firstly, commodification provides the link between design and domestication being a "process through which objects and technologies emerge in a public space of exchange values and in a market-place of competing images and functional claims and counter-claims" Silverstone and Haddon (1996, 45). Additionally it refers to "the industrial and commercial processes that create both material and symbolic artifacts and turn them into commodities for sale in the formal market economy" Silverstone and Haddon (1996, 63). It is important to understand that commodification also consists of imaginative work by producers as "commodities are constructed as objects of desire within an advertising and market system" as well as by prospective consumers as "goods are imagined before they are purchased, prior to any loss of illusion that comes with ownership" Silverstone and Haddon (1996, 63). Finally, the commodification dimension also deals with the transgression of boundaries, of that of the public domain into the private domain, and with the circulation of goods and images from the market into the home respectively. As such in this phase, intermediaries play an important role by linking up different domains and providing circulation channels between them in order for producers to 'catch' consumers and for consumers to 'find' products.[10]

Secondly, appropriation involves the activities in which "socially located individuals ... buy and then accept the new object or product into their own domestic environment" (Silverstone and Haddon, 1996, 64). Of central understanding of the appropriation dimension is the translation work involved for the consumer-user: "For an object or technology to be accepted ... it has to be made to fit into a pre-existing culture" (Silverstone and Haddon, 1996, 64). This 'fitting-in' translation work can be subdivided along the axis of space ('where is the object used and what does this mean?'), in which case it is termed objectification, or along the axis of time ('when and how is it used?'), captured under the heading incorporation. It is important to understand that the dimension of appropriation can be further complicated by competing or conflicting claims of family or peer group members over the 'right' appropriation.

Thirdly, conversion "signals the importance of the need to legitimate ones participation in consumer culture in the display of competence, and ownership" (Silverstone and Haddon, 1996, 65). With regard to conversion it is important to note that "it is through conversion that the spiral of consumption continues to turn, for in our converting activities ... those involved in commodification (producers, regulators, advertisers, and the rest) learn about consumption and may or may not alter their products and services to fit what they think they have learned" (Silverstone and Haddon, 1996, 65). In other words, conversion is in essence about circulation of knowledge from users back to producers. In

[9] The naming of the different dimensions varies between the different publications. In Silverstone et al. (1992) the first dimension is appropriation, whereas in Silverstone and Haddon (1996) it is labeled commodification and objectification and incorporation are grouped together as sub-items under the heading of appropriation. For the sake of clarity I follow the naming of Silverstone (2006).

[10] Stewart (2007) argued for the importance of intermediaries enabling social learning between users and producers in innovation processes.

this sense it is a type of translation that is similar to that of commodification, but then flowing in the opposite direction.

Finally, domestication "is as complex and contradictory a process as design"; and similarly as design, domestication involves a lot of work "only in this case the players are in the consumption rather than the production game" (Silverstone and Haddon, 1996, 67). The different types of work involved in domestication include practical, symbolic and cognitive work.[11]

To return from domestication theory to my analysis of domestication work: the narrative of this chapter is structured upon the different dimensions of the domestication process as outlined by the pioneering work of Silverstone. The main focus of this thesis — in this chapter as well — remains on the visible and invisible work involved in community innovation as enacted by all its participants, including home users. How to follow this type of actors to get an insight into their domestication work, is the subject of the following section on methodology.

3.1.3 On method

In addition to the overall methodology of this research project (see Chapter 1, Innovation by communities) this subsection briefly mentions how I collected empirical data on home users and their practices of use or non-use. The reason for expanding on method,[12] is that applying the standard STS adage about just "following the actors" (Latour, 1987), is not always easily applicable when dealing with home users.

Often home users, let alone non-users, have little motivation to participate in research [13]. Additionally, home users are often reluctant to allow researchers to enter the privacy of their homes. So, the first attempt of recruiting Wireless Leiden home users for interviews and observations by publishing several announcement in local newspapers, the Wireless Leiden website and Wireless Leiden user mailing list yielded no response. Apparently, Wireless Leiden home users were not interested in participating in research on their activities. Using the so-called "snowball method" asking active Wireless Leiden volunteers if they knew home users who could be approached for interviews, did not bring in any respondents either.

Before I could follow home users, I had to get into contact with them first, and secondly persuade them to participate in my research as respondents. For overcoming this situation the notion of 'visiting as a guest' as suggested by the Dutch scholar Arie Rip (2000) proved to be especially productive. Only by 'visiting' Wireless Leiden and repeatedly attending different types of local meetings, I was able to interact with home users and eventually persuaded

[11] See Oudshoorn and Pinch (2007) on the different types of work involved in domestication.

[12] Methodology is not something on which researchers within the field of Science and Technology Studies explicitly devote large volumes of written text on. This is evidenced by the fact that in the two most recent editions of the Handbook of Science and Technology Studies, a chapter on methodology is completely lacking. For example, see Hackett et al. (2008); Jasanoff et al. (1995).

[13] For an example from literature on studying use practices in everyday life and on how hard it is to find participants to cooperate in such a study see (Mackay, 2005).

some of them to participate in reporting on their experiences regarding Wireless Leiden. However, this was no easy undertaking, because for instance during free consultation without appointment meetings, regularly no users would show up at all. Only by attending these meetings over a longer period, I was able to interview and observe enough home users in order to obtain a group of respondents that was diverse enough to be representative for the remainder of the Wireless Leiden home users who were both invisible and inaccessible to me as a researcher. So only after a prolonged period, I succeeded to collect enough data for aggregation, and lastly for "giving voice" to the often invisible domestication work of home users.

This inherent invisibility of home users, is not a flaw in my methodology, but an inherent research problem for studying home users. This probably also has to do with the fact that usually the majority of home users form a silent group that is happily using the outcome of innovation communities. Some researchers studying the behavior of Usenet users, even go so far to present this invisibility "absentness" as an active involvement. Only when things start to break down users make themselvies visible, seeking assistance for solving their problems. Or when users have a need for functionality currently missing, they engage in active contact with members of the innovation community.

If possible, I scheduled additional interviews with home users at their own homes so I could have a look at their local 'Wi-Fi setup'. If people felt not comfortable with a home visit, people were interviewed over the phone; however this only happened once. Furthermore, empericial data on home use was collected while I accompanied a Wireless Leiden volunteer on several so-called site surveys. During this activity a Wireless Leiden volunteers helps prospective home users to find out if they can receive the wireless signals at their location. During these visits, people were interviewed ad hoc. With approval of respondents, pictures were taken of their home settings while the interviews were recorded to aid the production of full written transcripts afterward. Length of the interviews varied between half an hour to two hours. During observations at Wireless Leiden meetings, pictures as well as notes were taken. In total, ten people agreed to participate in research. Of these ten respondents, eight were home users, and two ended up as involuntary Wireless Leiden non-users due to failed appropriation. See table 3.1 for an overview of the home user respondents and some of their characteristics.

Because anyone is free to use the Wireless Leiden network without any form of registration, it is not known how many people are actually connected to the network from their homes. Although it is hard to say for sure how many Wireless Leiden home users there are, according to the maintainers of the various Wireless Leiden servers, over a few thousand unique computers have at least once had contact with one of the network nodes over the last years, based on the number of unique MAC-addresses numbers identifying individual Wi-Fi cards. However, it is not possible to translate this one-to-one to number of users, while a single computer can be used by several users, while one user can connect to the network by more than one Wi-Fi card. Asked about the use of the proxy servers, according to Wireless Leiden, usually a few dozen

Table 3.1: Overview home user respondents

Name	Sex	Age	Occupation	User since	Settlement
Ad	M	begin forty	IT administrator	2006	Leiden suburb
Ans	F	mid sixty	retired, full-time grandmother	non-user	Leiden outskirt
Chris	M	mid thirty	3 month stay in Leiden for work	2008	Leiden city-centre
Dave	M	begin twenty	medicine student	2007	Leiden city-centre
Floris	M	begin twenty	law student	2008	Leiden city-centre
Igna	F	mid thirty	lawyer	2005	Leiden suburb
Koos	M	begin forty	innkeeper	non-user	Leiden city-centre
Marc	M	begin forty	IT-administrator	2004	Leiden city-centre
Rob	M	mid forty	temporarily unemployed	2006	Leiden suburb
Tom	M	mid forty	long-term unemployed	2004	Leiden outskirt

users would simultaneously be connected to one of the three gateways to the Internet. One last remark: the total amount of Wireless Leiden home use has not been constantly over time. Home use appears to have had its peak during 2004 en 2005, according to Wireless Leiden volunteers based on anecdotal evidence about the number of people showing up during meetings and number of message on the Wireless Leiden user mailing list. From 2006 onwards, home use has decreased, partly because of the increasing availability of cheap ADSL Internet subscriptions. However, most data on home use was collected during the summer of 2008. Nonetheless two home users "from the outset" (when Internet access was offered starting in 2004) were interviewed about their experiences already in 2006 and 2007.

So to sum up the introduction: the central focus of this chapter is on how and why people living in or near Leiden are becoming — or are trying to become — Wireless Leiden users. The theoretical focus for studying and analyzing this process is the domestication approach pioneered by Roger Silverstone. The central question addressed is: How do people domesticate community innovations such as Wireless Leiden into their everyday practices at home, and what different types of work are involved in this process? The chapter is structured into subsections dealing with the different dimensions of the domestication process: (1) commodification, (2) appropriation consisting of (a) objectification and (b) incorporation; (3) conversion. In the conclusion the findings from the Wireless Leiden case-study are reflected upon as what this could mean for the general understanding of the domestication of community innovation. But before reaching any conclusions, let us dive into the data on Wireless Leiden.

3.2 Commodification (1): Catching the home user

Before actors can become users through a process involving domestication work, first there needs to be made available an object for the act of domestication. So

not only the domestication process itself involves work; also enabling potential domestication involves work done by those who design and build the object of domestication. Therefor, this sections focuses explicitly on how domestication work is enabled and constrained by those who initiated, designed, built, governed and represented the innovation. This is import to have a look at as well, because often in the early dynamics of community innovation, this is an activity not deemed important at all. Other wireless community networking initiatives in the Netherlands have never grown beyond the original small number of technical hobbyists, due to the lack of interest to involve home users by offering something they could 'domesticate'.

In the next section we look into closer detail on who is doing what in the process of translating Wireless Leiden from wireless infrastructure into an Internet access commodity desirable by home users.

3.2.1 Translating Wireless Leiden into free wireless Internet

The group of people who initiated Wireless Leiden was primarily interested in exploring existing Wi-Fi technology for new uses in outdoor settings. To them Wireless Leiden meant a giant technological playground, a 'mini-Internet under direct control', a 'living lab' or a platform to start ones own commercial Wi-Fi related activities. Although for explorers and for organizational users infrastructure in itself can be interesting, for most home users neither Wi-Fi technology in itself nor networking infrastructure is something to get very excited about. From the perspective of home users Wireless Leiden only became something of interest when the initiative announced that through cooperation with a commercial Internet Service Provider the network would provide 'free Internet access'. Adding the service of 'Internet access' on top of a 'wireless infrastructure' caused a spike in the local interest in Wireless Leiden. Wireless Leiden offered an interesting 'product' at such a low price point that potential residential users were willing to overcome minor nuisances and hassles regarding the installation and use of the network compared with the commercial Internet access alternatives. Just offering the service of free Internet access in itself was not enough; people needed to know about its presence as well. And this is where new actors come into sights, all involved in the further spreading of the Wireless Leiden network into people's homes. Let us have a closer look at what actors were involved in informing prospective home users on the presence and the possibilities of Wireless Leiden; and the work they were involved in.

3.2.2 Translating Wireless Leiden into attractive news

One of the most important type of actors involved in informing the general public about the presence of Wireless Leiden and its possible use as "free Internet" is the media in general and the press in particular. When I asked home users how they became informed about the existence of Wireless Leiden almost all of them they had either read about the initiative in newspapers, magazines or news websites, or heard about it on the radio. That most respondents

learn about Wireless Leiden through the media is not unsurprising looking at the numbers. The Dutch media mentioned Wireless Leiden 55 times in 2004, and 42 times in 2005.[14] Instead of informing the public through commercial advertising campaigns, Wireless Leiden succeeded in obtaining free 'marketing' through presenting themselves as 'newsworthy'.

Actually it is quite unique for a technology-focused volunteer organization to be able to receive sustained attention from the press over a longer period of time, both in local, regional, national and occasionaly international media. Within the Netherlands no other wireless community initiative received that much attention in the press.[15] In this sense Wireless Leiden could be called a champion in interesting the press. One of the big differences between Wireless Leiden and similar wireless community network initiatives is the professional manner through which they managed to involve the media in telling stories that created an image of Wireless Leiden as something that is 'a professional organization', 'run by volunteers', creating an 'innovative network', 'providing free Internet' to 'Leiden and its surroundings'.[16] Not only did many media items present Wireless Leiden as a credible alternative to commercial Internet Service Providers, some even claimed Wireless Leiden to be far superior to commercial alternatives. Some journalist claimed for instance that Wireless Leiden was being 'ten times as cheap, and ten times as fast' compared to ADSL or cable Internet available from commercial Internet providers. Creating the well-known 'Wireless Leiden' brand involved a lot of work on part of the volunteers who initiated the network.

So how did Wireless Leiden manage to inform prospective users about its existence and potential use? Or, in this instance, to be more precisely: How did Wireless Leiden succeed in interesting actors from the press to present the Wireless Leiden collective as something newsworthy?

One explanation of the success of involving the media could be that one of the volunteer board members previously had a professional career as press relations manager for the multi-national oil-company Shell. This provided Wireless Leiden with the competencies for managing contacts with press members and crafting press releases with a high capacity to interest members from the press. However, the availability of the competencies alone is not enough, the will to use these was present as well. A second explanation for the success of enrolling the media could be that the group who initiated the wireless network understood the importance of "informing" the public from the very beginning and made this an explicit goal of the project as a whole. Interviewing board members as well as reading the minutes of their meetings made clear "interesting the media" was one of the explicit goals from the early stage of the initiative. One element of building a socio-technical network was interesting the public at large. Wireless Leiden board member Huub, responsible for the public relations

[14] Source: Wireless Leiden website media archive, and the Lexis Nexis database archive of major Dutch newspapers.

[15] If only because most wireless community networks in the Netherlands are very small in number of nodes or active participants, they no longer exist or only very recently emerged.

[16] All quotes originate in Wireless Leiden press releases, sometimes translated from Dutch to English as not all texts were made available both in Dutch and English.

operations, explains how the initiative continued once they had figured out the technical design:

> "From then on we focused fully on so-called customers for our network and on creating public support and a broader reputation through the national press. Initially we managed to be in the press continually, with articles in newspapers and magazines, and also with interviews for radio and television, both locally as well as nationally. At first journalists were very skeptical, but after a while we acquired a reputation by building 'credibility'. At a certain moment journalists started to phone me whenever they had some Wi-Fi related questions. In their eyes I had become a kind of Wi-Fi expert. In the beginning we could realize all this publicity simply by being the first with anything we did. We have done our very best to use our 'first mover advantage'."[17]

Making phone calls to journalists and releasing press releases — notwithstanding how well crafted and sent to the right people — in itself is not enough to guarantee attention from the press, and more importantly to secure media reports.[18] A third explanation for the attractiveness of Wireless Leiden to journalists could be the 'charm' of the initiative's non-profit character. Because of its non-commercial aura, journalists might be prepared more easily to write an enthusiastic account about or give free publicity as it is a project they can sympathize with; something they would be much less inclined to do a similar commercial initiative.[19] One could say that Wireless Leiden evokes feelings of sympathy. One journalist explicitly refers to his positive views on Wireless Leiden when asked about his motivation to cover this topic:

> "Personally I think [Wireless Leiden] is a very sympathetic organization. It stands for free exchange of information and offering Internet access as cheap as possible. Also in places were conventional access methods are hard to obtain. [...] Wireless Leiden is a symbol for building a network that is offering free access. And that is an aim I am very sympathetic with."[20]

One last factor turning Wireless Leiden into a newsworthy subject, is that the project has been covered by the press many times before. In a smart move, all the articles and interviews are enlisted on the Wireless Leiden website, thus functioning as a rhetorical device conveying an image of 'credibility'. The subtext here this list is that if all those media found Wireless Leiden worthwhile

[17] Interview Huub Schuurmans, 2005-10-09.

[18] Additional strategies to become newsworthy are organizing special events like a "Wi-Fi on Waves war sailing" event; or even create an April's Fool press release on how the Wireless Leiden aerials are being used to search for extra-terrestrial life.

[19] For instance Yochai Benkler speculated the following about collaborative collectives engaged in peer production (Benkler, 2002a, 440): "It is, in any event, not implausible to imagine that individuals would be more willing to contribute their time and effort to NASA or a nonprofit enterprise than to a debugging site set up by Microsoft."

[20] Interview Suk-Jae Hummelen, 2008-12-12.

enough to devote their time to, then certainly it must be an interesting project. The relatively large number of publications tells a tale of success in itself. In this sense all the press reports themselves support Wireless Leiden, as testimonials to the capacity of evoking interest in the project. To top it off, the 'Wireless Leiden in the media' web page depicts a television crew filming a Wireless Leiden board member (see figure 3.1 on the facing page). In a certain sense this web page is a kind of 'citation-analysis in-the-wild' proving a proof of the 'impact-factor' of Wireless Leiden in the media. The web page provides links to the original publications (if possible on corresponding websites), to scanned pdf-versions, or to digital audio recordings of radio-coverage. This additional service enables the media reports to function as intermediaries for 'giving voice' to Wireless Leiden, and while doing so underscoring the importance of the project. Additionally, the press reports enable further circulation of information about the presence of Wireless Leiden and its possibilities into to new environments, far beyond the confines of the city of Leiden.

3.2.3 Translating Wireless Leiden into hyperlink-hub

Another medium that helped to increase the visibility and credibility of Wireless Leiden was the World Wide Web. Many respondents reported that one of the first things they did after they heard about Wireless Leiden and became interested enough to find out more about it, is that they started searching the Web for information. This process of "becoming informed" of potentially interested actors and the involvement of the World Wide Web is also something that was actively anticipated by the group initiating Wireless Leiden. In a similar manner as devoting a lot of work to a "media visibility campaign", one of the board members used his expertise on what is known as the skill of 'search engine optimization' (also known as SEO within marketing jargon), which main aim is to get listed as high as possible on the result pages of search engines. However, this time not journalists were the actors to be interested, but search engines in general, and Google in particular were the elements needed to made interested in order to be translated into the Wireless Leiden network.

Jasper Koolhaas, one of the people who initiated Wireless Leiden, explains what he did to increase traffic to the Wireless Leiden website:

> "And I pushed that [information about Wireless Leiden] really hard into Google, and on hundreds of other websites and especially on websites doing things with wireless Internet stuff. With the result that if one starts looking for wireless and Leiden, automatically you end up there.[...] And in the beginning we did something else that was also really important, we put up a wiki site. That is a website where anyone can change anything. Well this lead to the situation that in a very short time span a huge amount of information and links to information was assembled. And yes, from then on when you search on wireless within the Netherlands you end up at Wireless Leiden. And everybody respectfully links to us. So that caused for a lot traffic on our website. Some people

Figure 3.1: Camera crew filming Wireless Leiden board members

> think this is commercially very interesting, but I myself find it very interesting that all those people are following us and additionally also contribute things, ideas, that creates a situation where people see you as epitomizing the wireless movement."[21]

Interestingly enough, not only (core) members of Wireless Leiden are considered experts regarding Wi-Fi matters; Wireless Leiden as a network-folded-into-actor itself, mediated through its website and wiki, became a center of increasing expertise and knowledge. Knowledge on Wi-Fi matters was dispersed in persons' heads all over the Netherlands, and even abroad. The Wireless Leiden wiki enabled anyone to share their local knowledge in a 'center of learning' focused on using Wi-Fi for building community networks. And thus the increasing dynamic knowledge base of the wiki created a centripetal vector of interest attracting more and more actors interested in Wi-Fi related matters. Websites and wikis from similar Wi-Fi community network initiatives also added weight ("Google glue") by linking to specific pages in the Wireless Leiden wiki. An example of a popular page on the Wireless Leiden wiki provided information on how to 'hack' certain devices to add specific functionality missing in the original manufacturers firmware.[22] Adding or altering functionality to Wi-Fi devices was interesting for users beyond the geographical location of Leiden as well. The wiki thus functioned as a database built bottom-up by users, providing specific technical details of Wi-Fi devices and products such as specific chip sets manufacturers were reluctant, unwilling or simply unable to provide. One could say that the Wireless Leiden wiki functioned as a device enabling 'cycles of feedback' where users reacting on and adding to the original knowledge increased the value of Wireless Leiden as whole.

3.2.4 Strategic commodification work

In the case of community innovation where the availability of a novel technology or service is not announced via the market. this means that other information channels need to be found; and intermediary actors for further information dissemination need to be interested and aligned. Work is required to inform others about the existence and potential uses of a community innovation. Without devising an 'information strategy' and putting it to work, growth will probably not occur, or only very slowly. The case of Wireless Leiden showed three successful strategies for doing so.

The first is creating a discourse that presented an image of Wireless Leiden as 'innovative Wi-Fi infrastructure', 'providing zero-cost Internet', 'organized as local, non-profit, volunteer, cooperative'.[23] Especially this last characteristic helped to arouse interest from journalist based on the altruistic halo of Wireless Leiden. Combined with the previous elements, this created a strong interest and willingness from the press to present Wireless Leiden as 'news'.

[21] Interview Jasper Koolhaas, 2005-10-25.
[22] See the Wireless Leiden wiki website.
[23] All quotes from the Wireless Leiden press release archive available on-line.

The second strategy is devising a strategy for increasing visibility through 'findability' on the Internet in general, optimizing search engine results in specific. Another aspect of this strategy is devising a plan on how to become a 'center of use experience' on a certain technology, in this case outdoor Wi-Fi, consisting of increased 'aggregated localness'.[24] By providing free access to infrastructure for the aggregation and circulation of content contributed by both visitors from outside the innovation community as well users inside the innovation community, in this case adding a wiki to its website, Wireless Leiden quickly became a 'hyperlink-hub' causing an increase in weighed search engine results, for instance the search results provided by search engine company Google.

As we will see in the next section, the third strategy consisted of sustained freely accessible local information meetings at regular intervals. Additionally strategic partnering with local actors such as libraries, cafes and the local municipality took place to obtain housing or meeting accommodation as a physical 'point of presence' for welcoming, informing and persuading interested actors into actual home users. Taken together these three strategies helped Wireless Leiden as collective actor to gain wider reputation within the Netherlands as successful initiative and a strong 'brand name' arousing interest from home users.

Summing up: free access to community innovation does not equal an automatic influx of home users; this requires work, which van de nicely captured by the term commodification work as introduced by Roger Silverstone. If actors are unaware of the existence and uses of something new, they will never even consider using it. This might also explain why similar initiatives in other parts of the Netherlands that technically equally advanced (for example the Wireless Amsterdam initiative), however were lacking a public relation strategy failed to increase in size due to home users' lack of interest.

3.3 Commodification (2): Finding the community innovation

3.3.1 Becoming informed

In this section we follow home users onto their journey of becoming Wireless Leiden home users. For some this process is a straightforward story. For others their journey resembles more of a long and winding road. Three elements are recurring in all accounts of this part of the commodification process of Wireless Leiden:

1. Becoming informed
   How do actors become informed about Wireless Leiden; and what work is involved in this process of becoming informed?

[24] On the notion of aggregated localness, see Deuten (2003, 47).

2. Valuing an innovation as acceptable or 'desirable'
   How do actors accept Wireless Leiden as "desirable" or not; and what work is involved in this process of acceptance?

3. Acquiring the necessary 'stuff'
   How do actors acquire the necessary equipment to connect to Wireless Leiden, and what work is involved in this process of acquisition?

Local meetings

A unique feature of Wireless Leiden is its locally entrenched presence in the city of Leiden. This offers prospective users or potential participants of the network the chance to interact with the people behind it face to face. This strong tie to a specific locality is something Wireless Leiden has also tried to integrate into its network building strategy. If people are interested in becoming involved in, or want to connect to, the network they are kindly invited to visit one of the monthly 'open meetings' or attend the weekly 'free consultation without appointment hour'. This is also an explicit strategy to bring potentially interested actors into direct contact with already involved participants.

For people who are interested, but are not yet certain if Wireless Leiden has something of value to offer them, they usually carry on their exploration after hearing or reading something about Wireless Leiden into visiting an open meeting or attending one of the weekly walk-in consultation hours. Directing potential home users towards meetings with other already actively involved people also forms one of the first barriers towards becoming involved. The following reconstruction of an historical Wireless Leiden meeting offers a closer look at how Wireless Leiden is enabling people to become informed at an open meeting or a weekly consultation without appointment.

"Join and get connected!"

Leiden, Sunday morning, 4 January 2004, two o'clock in the afternoon. The extra room of local cafe 'Sociëteit De Burcht' is getting over-crowded to an increasing influx of visitors. The number of chairs in the hall that is usually installed for jazz concerts of literary evenings will certainly not suffice this time. Numerous people are already sitting on the floor and many others are leaning against the walls. The unexpectedly large number of visitors is attending an 'open meeting' titled "Join and get connected!".[25] According to the announcement it is "a workshop focused on practical questions and answers on how to connect to the Wireless Leiden network".[26]

The event described above enables us to travel back to a point in time at which a large number of Leiden inhabitants became interested in the promise

[25] The original Dutch title for the meeting was "Aansluiten!". Due to the various different meanings of this phrase in Dutch - simultaneously referring to the linking of persons (joining) as well as the linking of things (connecting); and additionally also referring to the activity of lining up in a queue - I choose to try to convey this double meaning by using a double translation.

[26] Source press release Wireless Leiden, on-line available.

Figure 3.2: Open meeting on how to get connected to the network.

of "free fast Internet" offered by the local Wireless Leiden volunteer initiative (see figure 3.2). One of the organizers of the event, Jasper Koolhaas, explicitly mentioned the event during an interview:

> JK: "When free Internet access arrived, that was a huge boost. At that time we organized a few meetings that were really crowded, with about two hundred people attending."
> SV: "So many people from Leiden who were all interested in finding out more on how it all functioned?"
> JK: "Yes, really unimaginable ... Once at a meeting, we just had to close the doors and send people away telling them there would be another meeting next month, please come back then. There were just too many people attending. It was chock-full; there was simply no room left anymore..."[27]

This overcrowded meeting was a turning point in the development of Wireless Leiden. What had started as a technical project initiated by a small core of hobbyists, now changed into a local innovation in which a large and diverse group of potential users was interested. The crux of the translation from invention to innovation in the case of Wireless Leiden occurs when the collective offers a type of use that hooks into potential home users every-day lives. Looking up things on the web, sending e-mails or listening to radio on the world wide web. Suddenly this was all possible in Leiden, fast and free. At least, if one was living in Leiden and could get connected to Wireless Leiden. The high-numbered public is interested, partly because commercial alternatives for Internet access,

[27] Interview Jasper Koolhaas, 2005-10-25.

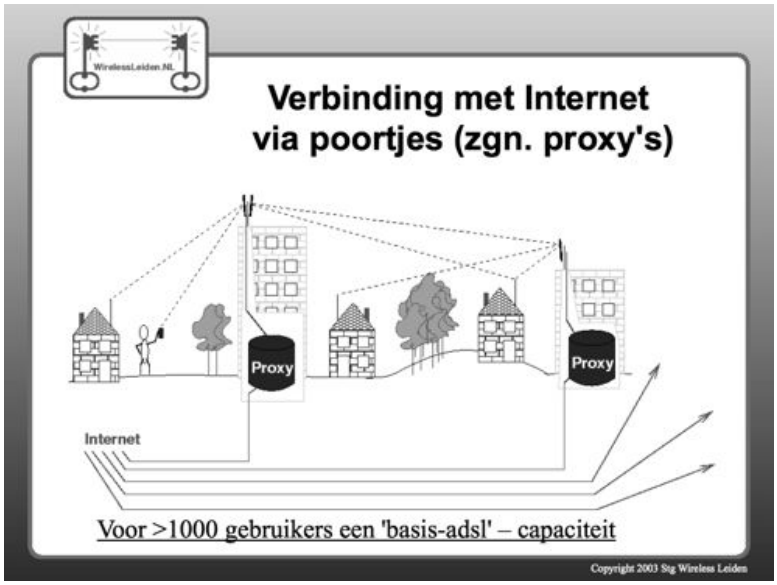


Figure 3.3: Open Meeting Wireless Leiden, January 2004: Informing and interesting actors

such as cable or ADSL are still relatively expensive and slow at that time in the beginning of 2004.

During the meeting the speakers explained the technological design of Wireless Leiden (see figure 3.3). However, at the same time they did more. They also interested the public, so they could use their support for the further building and extending of the wireless network. This was accomplished by seducing the public with the promise of free and fast Internet access through the Wireless Leiden network. The core group tried to move members of the public to make available the rooftops of their homes for the installation of new antennas; to help with the building and maintenance of new nodes, to help other people to connect themselves to the network; or collectively as a street pay for the installation of new hardware of a node that will enable their street to as a whole to connect to the network.

The central message was clear: Wireless Leiden is no shrewd commercial organization, but a friendly bunch of local volunteers trying to build free infrastructure for the local community. At first glance, the aim of this meeting seems familiar with that of an ad on television: namely seducing consumers to buy a new product or service. However, the big difference is that the core group of initiators behind Wireless Leiden are not trying to configure their users as passive consumers programmed to buy a ready-made product. Instead, their role as 'consumers' is to become active participants of an emerging innovation. Wireless Leiden as a project can only succeed if everyone, including home users, contributes by participating actively and voluntarily.

In addition to the open meetings, one of the board members took the

initiative to start a weekly recurring consultation without appointment. The Wireless Leiden website was used to announce the schedule. Every Wednesday during eight and nine in the evening people were free to drop by with their questions and possibly also their laptop computer given they owned one. This additional possibility for interaction between people trying to get connected and Wireless Leiden volunteers was facilitated by the fact that the organization had been enable to secure their own "home" premises in an building shared with a local non-profit organization as a result of lobbying the municipality for their own office-space within the city center. So similar of having the option to a general practitioner consultation without appointment in case of health problems, Leiden inhabitants now had the opportunity to visit a Wireless Leiden expert in case of wireless network problems.

One of the things that struck me during my observations of this kind of meetings was the use of jargon by the Wireless Leiden members, and the confusion this caused with the visitors. Technical concepts such as "node map", "access point", "interlink", "SSID", "antenna polarization", "ping", "DNS", "proxy", "port 80" or "HTTPS" were populated every other sentence uttered by the Wireless Leiden experts. For most visitors all this jargon can come across as some quite intimidating gobbledygook. One respondent, Rob — now a Wireless Leiden volunteer himself — vividly remembers his first introduction to Wireless Leiden:

> "So I had heard about Wireless Leiden from someone. And I decided well let's go there [to the consultation without appointment] and see what it's like. And the first time I was there, I was totally flabbergasted. I was wondering, for Heaven's sake, what are they talking about? About a proxy and how to configure a port and how to do this and how to do that. I felt like where on earth did I end up? [laughter] Yes, I was completely overwhelmed by it. But I had decided I better just let it all pass over me. Luckily some of the volunteers keep explaining things and do so in a quiet manner. So that was the reason I decided to just keep attending these meetings."[28]

Wireless Leiden announcing itself via Wi-Fi

Quite surprising, not only people are involved in making others aware of the presence of Wireless Leiden. The network itself — or to be more precise its radio beacons — also act on their own presenting people with the possibility to connect. One the respondents told how she was contemplating whether to sign up for ADSL or cable Internet or continue using her ISDN connection, when suddenly a third option emerged out of thin air. Or in words of Igna:

> "My father was staying at my house. He had also brought his own laptop with Wi-Fi. When he was sitting in the garden he suddenly said: 'Hey, look at what I can suddenly do'. [...] And then it turned

[28] Interview Rob van As, 2008-07-23.

> out it was actually working quite well on the laptop and we could actually do about anything we thought we would want to do with the Internet."[29]

To this woman, who had only vaguely heard about Wireless Leiden, but never considered it a viable solution for accessing the Internet, the local appearance of the network suddenly turned it into an acceptable solution to upgrading her Internet access from her current dial-up modem connection. Interestingly enough, the simple fact of Wireless Leiden becoming visible, normally invisibly present in the air in the form of electromagnetic radiation, sometimes becomes an actor itself, mediated into a human-visible form by people's computer screens, which was enough for this actor to reconsider her view on its usefulness.

The story above is certainly not unique. Two other respondents also claimed to became aware of the possibility of surfing the web via Wireless Leiden, when they fiddled with the Wi-Fi settings on their computer. However, when talking about it a bit longer, these respondents actually appeared to be using other people's unsecured, open access points without even knowing so. One respondent, Tom, relates how he only later figured this out:

> Respondent: "I was staying in a flat with someone for a month. And there really high at the eight floor, I was sitting with my computer behind the window, and I had such a card installed with a little antenna. Gee, I could really receive complete batteries of access points. And then I start fiddling around a bit [...] So at a certain moment I though, wow, I am really glad that I have Internet. [...] and I had the feeling I was really using Wireless Leiden. But only later it turned out I was just piggybacking on other people's network."
> Researcher: "So when you were logged in, you thought this must be Wireless Leiden?"
> Respondent: "[laughter] Yes!"[30]

Another example was when during an observation I saw how a women proudly demonstrated to me how she was able to surf the web by connecting to Wireless Leiden. However, upon further inspection of the name of the access point she was using it was immediately clear that is was most certainly not part of Wireless Leiden. This is clearly an illustration of how technical details that are self-evident for the Wireless Leiden participants, however are absolutely not trivial for home users. And how even connecting to the network, which is as simple" as clicking on an icon on the computer screen, requires additional knowledge about the design of Wireless Leiden.[31]

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[29] Interview Igna, 2006-02-23.

[30] Interview Tom, 2008-08-07

[31] Another common 'mistake' made by home users is that they try to connect to so-called 'inter-links'. These are wireless links that are meant to connect nodes, and are not meant to be used by end-users. Although the so-called SSID (Service Set IDentifier, the official name for authentication method to distinguish different 802.11 Wi-Fi nets from each other) of these connections differs from the real access points, for many people this difference is not clear at all: for them the difference between for example *ap-omni.hofwijck.wleiden.net* and *il.hofwijck.wleiden.net* is not significant.

Although some people might think they are accessing the Internet through Wireless Leiden, actually getting connected usually involves a lot more work because the default settings of the Wireless Leiden certainly do not favor an easy connection to the Internet. Although connecting to the Wireless Leiden "intranet" is easy, configuring access to one of the proxy servers functioning as a gateway to the Internet is certainly not trivial. Due to the design of how the nodes present themselves to connecting computers a lot of additional configuration is necessary at the "client side". Although there are technical solutions to provide all this necessary technical details in a manner that allows for a "transparent" connection to the Internet — a solution under the name of captive portal — Wireless Leiden actively choose to not implement this on their network.[32] Not because they were unable to, but simply because they favored the use of the Wireless Leiden network as 'intranet' — as preferred by the initiators of the initiative — over the 'simple use' of Wireless Leiden as 'free access Internet'.[33] Although I was a bit surprised by this design decision at first, it actually follows directly from the aim of Wireless Leiden to be a 'wireless infrastructure' instead of an Internet provider. Additionally, this design decision also fits in nicely with the Wireless Leiden principle that users should become actively involved. This active stance is also required to get connected.

Or as one journalist living in Leiden himself nicely summarized his own experience with trying to get connected:

> "Anyway, I have to admit that when you visit the [Wireless Leiden] website it looks all very sympathetic, well-organized and very professional. However, if you then are really in doubt if you should use it or not for your own Internet access, then suddenly the story becomes a lot more complicated. At that point I think it is best to visit the weekly free consultancy hour, to get advice on how to fix up everything the best way."[34]

So although it might require a more active stance from a prospective user to connect to the network, free facilities for help and support are available as well. Let us continue with our journey following home users in their activities finding out how to get connected to Wireless Leiden, and how to find out if it is really something for them to get involved in.

3.3.2 Desiring Wireless Leiden

After people have become informed about Wireless Leiden and its uses - by hearing stories, reading articles, surfing the web, visiting local meetings and perhaps even consulting with volunteers or other users, they arrive at a 'consumption junction' (Cowan, 1987); a point in time where they decide on whether

[32] The fact that they implemented the captive portal feature in the nodes at the offices of the Leiden public library shows they were clearly aware of the option and how to implement it.

[33] Huub Schuurmans, one of the Wireless Leiden volunteer board members, when assisting home users repeatedly referred to the proxy-configuration details as "the secret PIN code for Internet access".

[34] Interview Suk-Jae Hummelen, 2008-12-12.

they continue with their journey on becoming a Wireless Leiden user, or not. The question then becomes: How do people become to value a community innovation such as Wireless Leiden as 'desirable'?

The thing that attracts attention looking for an answer to this question, is the great diversity in motives for people to start thinking about Wireless Leiden as something they "want" or have a need for. Before studying this diversity in greater detail, the general pattern that can be discerned is that three main themes seem recurring within the different 'desirability narratives'. The first theme is about zero-cost Internet access. The second theme is about Internet availability under specific local circumstances for which commercial broadband access offers no viable solution. The third theme is about the specific design of Wireless Leiden, technically and socially. This narrative stands out for not being about Internet access, but about Wireless Leiden as a social volunteering organization and wireless computer networking laboratory. Let us have a look at these three recurring themes in closer detail.

Goody: zero-cost Internet

As we have seen the press most often translated Wireless Leiden to a "free Internet", doing so based on press reports or interviews with board members. Not completely unsurprisingly many people picked up this message and began to consider Wireless Leiden as an alternative to their ADSL or cable Internet. Especially in the early years of Wireless Leiden, when ADSL and cable Internet subscriptions were relatively expensive, many people in Leiden perceived as Wireless Leiden an attractive alternative.

Additionally, during information meetings, people interested in becoming users expressed another motive for connecting to Wireless Leiden. During question and answer rounds people from the public would often raise their frustrations with interacting with large near-monopoly Internet providers. Often they expressed strong emotional negative opinions about these companies, as they felt they were not treated respectfully, both as user as well as consumer. Some of these people were strongly motivated to try alternative ways of access to Internet, just so they no longer needed to be a consumer of these large companies. These people often perceived Wireless Leiden as an attractive alternative that treats its users respectfully. In return people were prepared to invest time and energy to get things working, as long as they could switch away from the companies they no longer wished to be a paying customer of.

In more recent years, the prices of Internet subscriptions have come down considerably, while download speeds and the number of companies providing Internet access have increased. As a result expectations about connection speeds have increased as well. At the same time the connection speed of Wireless Leiden has remained the same, or even steadily decreased. Especially in 2008 there were many problems with Internet access via Wireless Leiden because of unwillingness of the company to continue sponsoring the collective with free ADSL subscriptions. This put Wireless Leiden in a relatively unattractive position in contrast with commercial Internet access. The dynamic that can be seen here

is that Wireless Leiden dynamically evaluate what they think is an acceptable or desirable Internet access solution, in relation to alternative offerings. This is of course no surprise, however, it shows that even freely accessible or zero-cost "community innovations" are competing with commercially available substitutes.

Igna, an example of a user attracted by the low-cost Internet access, explicitly discussed the cost-factor:

> Researcher: "I am quite curious about how you decided to opt for wireless Internet, especially when you consider all the configuration work you have to figure out yourself, and the materials you have to buy."
> Respondent: "Well, up front we didn't know the cost of buying all the necessary things."
> Researcher: "But you assumed Wireless Leiden to be cheaper?"
> Respondent: "Yes, because it was a hobby project. And the shop owner from Kok was also really positive about it. And then we thought: 'If it is out in the air for free, then you should actually use it as well'. [...] I just wanted to experience myself if such a thing was really possible. [...] We also have young kids, and they are slowly discovering Wikipedia. And they are really enthusiastic about being able to find anything for school assignments. And they specifically like the fact that now they can access the Internet for as long as we let them play with it. I think that with an ISDN connection I would have had another opinion about such unlimited use. Because then every second you are connected costs you money."[35]

Nowadays, most people who use Wireless Leiden primarily because it offers free Internet access, are living on a restricted budget, and often have additional alternative points of access to the Internet. An example of a cost-conscious Wireless Leiden user with limited amount of money to spend is Tom, being unemployed for years. He opted to use Wireless Leiden as primary access point to the Internet, because for him it is "good enough", although it is neither fast, nor reliable. To cope with regular network outages, Tom uses his mobile phone with a cheap data subscription as a "back-up Internet" device, mainly to look up things on the web and check his free web mail account at Google Mail. Another example for whom Internet access at home is a "nice to have" instead of a "must have" is Dave, studying medicine at Leiden University. His father enrolled Wireless Leiden as volunteer, and as part of his hobby he offered Dave a configured set-up for surfing the web for free. In case of a malfunction, Dave phones his father to help him solve the problem. Because Dave can use the Internet facilities when is at the university during the day or evening, he sees the inherent unreliability of Wireless Leiden merely as a nuisance, and not as an insurmountable problem.

Unfortunately I was not able to find more people from this category, when I was collecting additional empirical data about Wireless Leiden home users during the summer months of 2008. However, it cannot be concluded that

[35] Interview Igna, 2006-02-23.

Wireless Leiden has become completely obsolete or unattractive for home users. As we will see, Wireless Leiden still attracts new users. Although admittedly no longer primarily attracted by the lack of a monthly Internet access fee.

Tool: alternative gateway to Internet

A second theme in the narratives of the respondents, about why they became a home user is Wireless Leiden as only available option for broadband Internet connection in underdeveloped area's. For instance, in some small villages and rural areas surrounding Leiden no commercial broadboad Internet was available (and sometimes still is not). Although the Netherlands is one of the most densely populated countries in the world, there are nonetheless lowly populated areas that still lack the option to subscribe to ADSL or cable Internet. For these households the Internet access options are very limited: use an old-fashioned analog modem (slow and no flat-fee); use an ISDN modem (still slow and no flat-fee); use a satellite-dish in combination with an analog modem or ISDN modem (very expensive, high latency and monthly maximum download limit); use a mobile phone as modem (expensive, slow and no flat fee). However, none of the options offers a cheap 'always-on' connection. For people living in such unconnected areas, Wireless Leiden provided a good alternative for broadband Internet access. An example of such a location lacking commercial broadband Internet is Kaag, a small village near Leiden. Due to long-distance connection between the village and Wireless Leiden, the people of Kaag could use the community Wi-Fi network as alternative for commercial Internet access.

Another user group in this category are people who are not sure how long they can reside at a specific location, for example students who live in an empty building as part of an anti-squat team. They have to leave the building within four weeks when a new buyer has been found. Because an ADSL or cable subscription has a minimum length of one year, the risk for them of having to pay for a service they can not use is too big. Foreigners staying in Leiden for a limited period of a few months encountered the same problem. For them Wireless Leiden offers a great, local solution.

As a third example of people who would like Internet at a specific location, I encountered people who spend their summer months living in the Leiden communal gardens. Because they have no 'official address' they cannot subscribe to ADSL or cable Internet services. Some even tried by making phone calls to different ISPs, only to find out that they can't become a customer, despite their wish to spend their money. As a last resort, these people consider Wireless Leiden as an option to connect to the Internet while residing in their quiet holiday home.

Toy: wireless playground and technical hobby community

The last main theme I could distinguish in the respondents' accounts on the attractiveness of Wireless Leiden is its character as a wireless playground and technical hobby community. People who are attracted to Wireless Leiden

because of this often already are connected to the Internet with a fast commercial broadband connection so for them connecting to the Internet is not what makes Wireless Leiden something desirable. Often this type of users is mainly interested in connecting to the wireless network to learn more about its characteristics as infrastructure technology. Whereas it is impossible for home users to open up the black box of the devices routing the digital bits on the Internet, within Wireless Leiden, they can get access to the underlying, usually invisible networking infrastructure. Some of these people do not even connect their homes to the Wireless Leiden network, because they can also log in to the Wireless Leiden network over their commercial Internet connection. So whereas for some home user the Wireless Leiden network is gateway to the Internet, for some of these users in a reversed manner the Internet functions as a gateway to the Wireless Leiden network.

For this category of users not the technology itself, but the possibility to learn about it within a community is one of the primary motives to connect to Wireless Leiden. However, they think of connecting as a more social than technical activity, meaning visiting open meetings and corresponding on one of the Wireless Leiden mailing lists. For these people Wireless Leiden functions as a "technical hobby community" or for some as a way to spend time in useful way being part of a non-profit local volunteer organization.

For this category it is the combination of the potential interaction with an enthusiast group of people with Wi-Fi networking expertise as well as a "mini Internet" they can play with, what makes Wireless Leiden so desirable to become part of by connecting to it.

3.3.3 Acquiring necessary Wi-Fi elements

After people start to desire a connection to the network, they often need additional "stuff" to be able to do so. Often they need to buy a combination of an outdoor Wi-Fi antenna, some weather resistant cabling, a long-range Wi-Fi card for their desktop computer or notebook, or instead of the previous an all-in-one solution. Depending on whether people want to mainly spend money buying ready-made solution or time creating their own "communicative assemblages", two main acquisition strategies can be observed.

Buying Wi-Fi

The first acquisition strategy is buying a quick-and-easy all-in-one solution, which usually consists of buying a so-called Wandy client; usually taking place at the only Leiden electronics shop called 'Kok Electronics'. This shop has been catering to the radio amateur market for decades, and as such had already acquired all the necessary expertise, competencies and skills to handle high-frequency radio equipment coming with it owns peculiar quirks and caprices. When one of the initiators of Wireless Leiden developed the "Wandy" solution, this shop was the first one to sell it within Leiden. An additional advantage of purchasing a Wandy at Kok, is that this shop also offers a "try before you

buy" service, where customers can take a Wandy home and find out if they can connect to Wireless Leiden in a satisfactorily manner. Many respondents told they were very positive about the service and advice they received from this shop. Usually when home users ask Wireless Leiden volunteers where they can acquire the necessary hardware, they are advised to go to this specific store.

Building Wi-Fi

The second acquisition strategy that can be observed is building ones own setup, consisting of a carefully selected mix of home-built elements and parts bought at several specialized shops. For some of these home users the sport is to build a setup as cheap as possible, others however focus on maximum performance, often exceeding specifications of devices commercially available by carefully picking the best combination of Wi-Fi cards, connectors, cabling, firmware, drivers, software and housing. Some seek an optimum somewhere between price and performance, for example by buying a relatively inexpensive Wi-Fi router on which they mount a home-built Wi-Fi antenna. Often home users delegate some of the more delicate and difficult tasks such as "crimping" Wi-Fi cabling to the local electronics shop. Whereas some elements such as antennas are actually quite fault-tolerant towards inexperienced home-builders, creating cabling yourself is often less forgiving and also requires some special expensive tools.

Although Wireless Leiden states that it is a non-profit organization, that does not mean that commercial transactions are completely absent. Firstly, the foundation itself sells second-hand 'long-range' Wi-Fi cards, after they had the chance to acquire a bulk of these devices very cheaply. People coming to the weekly free consultation hours who have not yet acquired a hardware solution, often are offered these cards for the very low price of 5 euros. The cards are sold under a 'no cure, no pay' guarantee. People can borrow cheap home-built bi-quad antennas from Wireless Leiden volunteers attending the consultation hours. For more demanding home users, the possibility exists to acquire semi-professional hardware elements directly from other Wireless Leiden volunteers or board members, who sometimes import such devices directly from manufacturers abroad.[36]

Buying and building Wi-Fi

An interesting local innovation is the sale of "bi-quad kits" by the local electronics store. In a similar fashion as Ikea delegates some of the work of assembling its flat-pack furniture, Kok electronics sells 10 euro "antenna kits" that can

[36] Sometimes the objects bought are hard to find within the Netherlands. Or they come with non-standard firmware versions, which are officially not legally allowed in the Netherlands. Several times I witnessed deals between Wireless Leiden board members where such hardware changed owners. However these transactions are not being advertised on the website or mailing lists, and officially do not fall within the scope of the official Wireless Leiden foundation. In the chapter on coordination work I look in detail into the relation between commercial activities within Wireless Leiden.

be assembled by its users by soldering them together at home. For users this is a convenient combination of a low price and the fun of putting it together yourself.[37]

3.3.4 Wrapping up commodification work

What stands in commodification work is the way in which Wireless Leiden, thanks to operating strategically, is able to interest and align actors in such a way that it becomes a newsworthy item in the media. Despite lacking financial budget for 'advertising', Wireless Leiden is able to build a well-known brand within the Netherlands. In this process the involvement of the press is central; additionally Google is a key actor in listing Wireless Leiden on top of its search results. Regarding acquisition of the necessary devices by home users, it is important to notice that there is much more choice available compared to commercially available Internet access. Another interesting development is the emergence of the 'kit' package, a development that is similar to other technical hobby domains such as amateur radio or model making. It is clear that in the commodification of community innovation there is a place for non-commercial build-it-yourself and doing-things-together initiatives, as well as for commercially packaged plug-and-play solutions.

3.4 Appropriation work

In this section we follow actors trying to connect themselves and their homes to Wireless Leiden after they have acquired the necessary equipment to do so. The main question this section tries to address is: What work is involved in appropriation by home users?

The first part of this section focuses on the objectification dynamics answering the question of what actors actually do when they arrive at home with the stuff they acquired to connect to Wireless Leiden. The topics addressed in this first part deal with giving things a place in users' homes; an activity constrained by factors such the electromagnetic geography of Wireless Leiden, factors limiting accessibility to the buildings users live in, and the acceptability of the aesthetics of certain solutions for other family members. Additionally, it often takes some experimentation to get things 'right', usually taking a while for setting up a stable configuration of devices and antennas that works.

The second part of this section delves deeper into the incorporation dimension, studying the actual use practices involving Wireless Leiden in everyday life.

In the third part of this section we focus on failed appropriation, as appropriation is no automatic success. Following actors who did not succeed into appropriating Wireless Leiden into their homes or use practices, we gain additional inside in how and why appropriation of community innovations

[37] For a similar observation in the amateur radio domain on the emergence of kits to overcome the tension between 'buying' or 'building' a device, see Haring (2007, chapter 3).

sometimes fails, despite enthusiastic or persistent attempts by would-be users. In short, I address the following three questions.

1. Objectification work*:*
   How do actors objectify Wireless Leiden into their homes; and what work is involved in the process of objectification?

2. Incorporation work:
   How do actors incorporate Wireless Leiden into their everyday life; and what work is involved in the process of incorporation?

3. Failed appropriation:
   How and when do actors decide their appropriation of Wireless Leiden has failed?

3.4.1 Objectification

This subsection focuses on the objectification dynamics answering the question of what actors actually do when they arrive at home with the stuff they acquired to connect to Wireless Leiden.

First let us look at the installation of the necessary elements that enable users to connect their homes to Wireless Leiden. When home users want to connect to Wireless Leiden they are limited in the ways how to by the following constraints: (a) Wireless Leiden signal quality at their specific location, (b) financial budget, (c) do-it-yourself competencies, (d) legal constraints on antenna size, placement and maximum signal power, (e) time constraints.

The ways in which home users try to connect their homes to Wireless Leiden shows a careful balancing between the different constrains. Home users who just want Internet, usually acquire an all-in-one solution. The most popular product, which is also advised by Wireless Leiden as the best solution for home users is the so-called Wandy, developed and commercialized by a former Wireless Leiden volunteer who started his own outdoor Wi-Fi equipment company. Although the Wandy device is not really cheap costing approximately 250 euros, at the time it was introduced in 2004 it was the cheapest all-in-one, weatherproof outdoor Wi-Fi client device with router capabilities available to consumer users. Although similar devices were available, none of them had a directional antenna built-in or a weatherproof casing.[38] Moreover, the Wandy was a complete solution. It contained everything necessary for installation, including a clear manual, 25 meters of Ethernet cabling, a mounting bracket, and even screws and plugs to wall-mount it. The Wandy was a true plug-and-play solution explicitly targeted at home users.[39] Once installed, a home user could easily forget the device and browse the web, until to be reminded of its being-there when the Wireless Leiden network would become unstable. Marc, one of the first Wireless Leiden home users, showed his contentment with his Wandy device:

[38] The Linksys WET11 was a device which at the time was popular within Wireless Leiden and other community wireless networks, although lacking outdoor weather-proofing.

[39] Interview with Johan de Stigter 2005-12-06.

> "At the moment I am using a Wandy client. I started with a Linksys WET-11. However,that thing has a much smaller antenna, and you cannot place it outside. So I had installed it inside the attic, but the connection was very, very flaky. Because there are so many rooftops, I have no line-of-sight connection [with the Wireless Leiden network]. At a certain moment I became fed up with the situation, and decided to simply buy a Wandy. The price is a bit steep. But by now the thing is out there for years, and I have experienced any problem whatsoever. It was a bit pricey, in total costing about 270 euros. At that time, I found that a lot of money. But it is worth it, you really get quality. The thing has been out there for years now, completely covered in pigeon-do, and still working great."[40]

Floris, another home user living in an empty office building, temporarily rented out to students to prevent others from breaking into it with the intention of squatting it, also used a Wandy. However, because of his limited budget he bought an older, second-hand model, costing only 75 euros.[41] This user was also pleased with how easy it was to setup his connection. Another advantage to him was the fact he could just place the Wandy in front of the window inside his main living room next to his computer, without the need to drill any attachment holes, something his tenancy agreement explicitly forbade.

Those with tinkering skills often combine low-cost devices with home-built aerials into a 'communicative assemblage'.[42] They do not want to spend a lot of money on device they can build themselves as well. Home user Ad put this stance into words:

> Researcher: "Did you ever contemplate buying a Wandy?"
> Ad: "This thing here [pointing to home-brew contraption, see figure 3.4 on the next page] is doing exactly the same and it is way cheaper. [Laughter]. No, buying a Wandy is something I never really considered. Actually, this thing here is also a simple version of a Wandy. When you put DD-WRT software on it, you can actually do anything you can do with a Wandy. Why should I buy an expensive Wandy then? [...] Well, yeah, if you don't understand how it all works, then you buy an all-in-one kit with everything included: power-over-Ethernet, you can easily mount it, the antenna is built-in [..] So if you don't have a lot of knowledge, then it is an ideal solution I guess."[43]

[40] Interview with Marc 2007-04-19.

[41] Actually, these Wandy clients had became available from the Lombox project in Utrecht, which started out as a grassroots community wireless network. However, after an increasing amount of subscriptions, the initiators decided that the use of glass fib re made more sense regarding total cost of ownership, capacity and reliability. The used Wandy clients were subsequently sold on Marktplaats, the most popular second-hand marketplace website. Here we see how devices that originated within Wireless Leiden, traveled into other wireless networks through the channels of commercialization, and then end their journey back in Leiden being acquired as used object.

[42] This notion was introduced by Slater (2006).

[43] Interview with Ad, 2008-08-01.

Figure 3.4: Ad's home-brew Wandy equivalent

Objectification work does not only involve work indoors but outdoors as well. Due to the regulations that limit the maximum amount of power for Wi-Fi devices to 100 milli-Watt, home users are usually limited to where they can place their antennas. To improve reception, antennas should be mounted outdoors to limit attenuation of the radio signal. Reception can also be improved by the use of special directional aerial with a higher-than-average sensitivity due to a larger size or the utilization of a reflector. Often both strategies are combined to achieve a good result. According to Dutch law, everyone is free to install an aerial on their house as long as the total height of the antenna remains less than 5 meters high, and it is not installed at the front of the house.[44]

However, although people have a large degree of freedom in relation to installing antennas, in practice they feel more restricted. A perceived disadvantage of attaching a large aerial to the outside of one's home, is that the device is highly visible for the neighborhood; sometimes evoking negative responses from neighbors who are concerned about potential electromagnetic radiation or harmful interference. Although such negative responses are well-known within the radio amateur community (Haring, 2003), home users are not accustomed to them. One Wireless Leiden volunteer who had also connected his home to Wireless Leiden revealed that he had intentially "stealthed" his Wi-Fi setup. He had made sure the aerials on the top of the building in which he was living, were out of sight when looking up from outside on the street in. He explicitly mentioned he hoped to prevent potentially negative responses from neighbors in the first place.[45] Tom, another home user and Wireless Leiden volunteer, had

[44] For the exact requirements for a building permit regarding antenna installations consult the flow chart in the regulations of the Ministry of VROM (2003).

[45] Interview Marten Vijn, 2005-10-14.

Figure 3.5: Tom's 'camouflaged' aerial in his living room

also camouflaged his quite large aerial by installing it inside his home, instead of mounting it on the outside. , this meant that the antenna now occupied space in his living room (see figure 3.5). Another home user, Ad, related how he had spent quite some time and "a ridiculous amount of money" to place a home-built bi-quad antenna into an unobtrusive black casing mounted on his roof (see figure 3.6 on the next page), "just to make it look nice".[46] An additional web cam mounted on his rooftop was withdrawn from sight in a similar fashion by hiding it inside a bird box. Asked for his motivation to do so, this user replied that his wife did not like "the ugly sight of strange objects on the roof of their house".

3.4.2 Incorporation

This second subsection focuses on the incorporation of Wireless Leiden into users' everyday life at home. What do actors actually use Wireless Leiden for once they have succeeded into configuring a working connection to Wireless Leiden? And additionally, what meaning do users attach to "their" connection to Wireless Leiden? After evaluating the data two different types of home use practices involving Wireless Leiden stand out which I labeled 'Internet access' and the second 'wireless playground'. In the rest of this subsection we look into detail into these two different type of use practices and the work that is involved in enabling them.[47]

[46] Interview with Ad, 2008-08-01.

[47] Additionally other types of use involving Wireless Leiden have emerged, such as using it to gain administrative or managerial experience governing a mid-sized volunteer organization; to scout potential employees; to employ as "living lab". However, these "use" practices do not take place by "home users" or in "home settings". These types of uses are dealt with in more details chapter 5

Figure 3.6: Ad's unobtrusive antenna placed in the left upper corner of the skylight

Internet access

The first category of use practices mainly involves surfing the web; communicating with people using web mail, or chat or VoIP programs such as Skype or MSN Messenger; and sometimes teleworking from home. What is central to this type of use is that the main focus is on getting things done by using the Internet as tool. As long as the Internet connection works, Wireless Leiden itself remains invisible, 'sunk into the background' of the underlying infrastructure. And this is exactly the way home users want it to be: Wireless Leiden as black box, for example packaged in a Wandy. Only when the Internet connection fails because of a connectivity problem, home users become aware again that they connect to the Internet via Wireless Leiden, and that they might need to pry open the black box of Wireless Leiden in order to return it into a functioning state again.

Wireless playground

The second category of use practices centers around experimentation with, exploration of and learning about wireless computer networking as infrastructure technology. Here the direct involvement with the infrastructure itself and all its elements is the main aim of its use. The Internet is only used as a communication and information retrieval tool, to facilitate the experimentation. And when everything is stable, and working, ready to be black boxed, to collapse from network into actor, then it is time to shift focus to another element of Wireless Leiden, to expand that actant into a network of its constituting elements. Whereas the first type of use backgrounds the underlying infrastructure,

(Coordination work).

this second type of use actually foregrounds the infrastructure itself. Whereas Bowker (1994) argued for an 'infrastructural inversion' as an analytical tool, in this case the infrastructural inversion is taking place as a 'serious leisure' activity by the actors themselves.[48]

Temporary shifts in use

An interesting observation was the casual emergence of a cross-over between the two different types of uses alternating between Internet access and wireless playground. An additional third type of potential use practice mentioned by respondents, consisted of Wireless Leiden as 'back-up Internet access'. Although some users perceived this potential use practice as an additional advantage of their Wireless Leiden connection, neither of them had actually been engaged in this type of use nor have I encounter it in direct observations. However, this use does not differ much from the first use type, but then used by people who normally use use Wireless Leiden as playground and not as Internet access. So although this type of users are aware of advantage of using Wireless Leiden as Internet access, and they label this function as back-up Internet, they normally do not actually engage in this type of use, because they already are connected to the Internet by means of their commercial ADSL or cable Internet subscription.

3.4.3 Failed appropriation / non-use

Wireless Leiden offers Internet connectivity that is attractive for Wireless Leiden residents for various reasons. Especially people who feel that their needs are currently not addressed by commercial Internet service providers active within the Leiden region, are particularly interested to become connected to Wireless Leiden. In this section I follow potential Wireless Leiden home users who are highly motivated to 'join and connect', but ultimately fail. In order to balance the 'success' image of Wireless Leiden I offer two short tales of failure. For the actors followed in this section, Wireless Leiden ultimately represents a 'failed innovation' at the moment they become involuntary non-users.[49]

The first failure story is about Koos, working as innkeeper in a pub in downtown Leiden, who would like Internet access in order to pay his bills online. I encounter him when he visits one of the Wireless Leiden free consultation hours (see 3.7 on the following page). To one of the volunteers he tells why he comes to visit Wireless Leiden. Previously he was using the Internet connection of his neighbors in return for a small monthly fee. However, last week his

[48] The notion serious leisure was introduced by Stebbins (1982).

[49] There is not much research literature on failed innovation. A noteworthy exception was the 1992 symposium on failed innovation which resulted in a special issue of Social Studies of Science (1992, vol 22, issue 1). Also see Cooper and Sinclair (1990) for a similar symposium. For an introduction to the theme of failed innovation, see Braun (1992). Empirical case-studies as examples of innovations that failed to be successful appropriation include the Itera plastic bicycle (Hult, 1992), the gas refrigerator (Cowan, 1983, 1985) or the electric plough (Todd, 1992). By and large we might conclude that even in attracting attention as a topic for research, failed innovations actually fail. For an analysis of the different types of non-users, see Wyatt (2003).

Figure 3.7: Koos visiting the Wireless Leiden walk-in consultation hour.

neighbors moved out, and the new inhabitants are no longer willing to share their Internet connection. When Koos then investigated the alternatives he disliked the price of the monthly subscription fee, which would be considerably more than the few euros he had been paying his neighbors. Most importantly, he told that to him it was unacceptable he would have to week four to eight weeks before his connection was installed. In analytical terms, Koos could be described as deliberately 'rejecting' the current commercial offerings. When one of his barmen told Koos about Wireless Leiden and the free Internet access it offered, that seemed like a more attractive and economical solution for his occasional Internet use. After Koos has explained his situation, the volunteers first start to explain the technologies involved in creating a connection. Clearly, Koos is slightly overwhelmed by all the technical jargon. In order to explain how Wireless Leiden works, one of the volunteers guides him to a map on the wall schematically showing the locations of Wireless Leiden nodes, and their interlink connections. After asking his address, the volunteers then starts looking up the nodes in the vicinity of Koos' homes (see figure 3.8 on the next page).

This map is often used during consultation hours by volunteers in order to translate user requesting connectivity into a matter of geographical proximity.[50] After a short discussion between the volunteers attending the consultation hour on the options available, one of them offers to help Koos by coming over to his home to do a so-called 'site survey'. Although in theory the question: "can I connect or not?" might seem simple, in practice it is not. Find out if someone is able to connect to the Wireless Leiden network requires a so-called "site

[50] In terms of Star and Griesemer (1989) one could understand the map as boundary object, creating an overlay of the schematic Wireless Leiden network over the geographical Leiden area.

Figure 3.8: The Wireless Leiden map in action.

survey". This is a test involving actual measurements with a specially rigged laptop paired with a home-brew measuring device and sensitive antenna. The activity of scanning the surroundings for Wi-Fi signals, is often referred to as 'stumbling', named after a popular software tool specifically targeted for this purpose. The next day I accompany the volunteer in order to join the site survey. The WL volunteer has brought with him various tools and devices in order to test if the Wireless Leiden Wi-Fi signal can be received at the Koos' house (see figure 3.9 on the following page).

Unfortunately, after some thorough testing it seems that the available signals in this particular location are too weak in order to create a stable link. The volunteer explains that it is probably due to interference because of other Wi-Fi devices, or because buildings are actually blocking a clear line of sight. After some discussion with Koos stating his disappointment, a second attempt then is made at the pub where Koos is working. However, all the work is to no avail. All in all, the complete operation of doing site surveys at two different locations, took almost half a day. When the volunteer concludes that currently no connection can be made to either his home nor his pub, Koos is left behind somewhat disillusioned and expelled by neither being able to join nor connect (see figure 3.10 on the next page).

The story of Ans offers a second illustration of a trajectory of failed appropriation of community innovation by a prospective Wireless Leiden home user. Similar to the previous story, I meet Ans when she visits the walk-in consultation hour. In a nutshell, her particular reason for wanting to 'join and connect' is because she is 'excluded' from Internet access during summer months. In that period she primarily spends time at her summer house built on her parcel at the Leiden allotment gardens called "Ons Buiten" (literally translated from Dutch

Figure 3.9: Doing a site survey.

Figure 3.10: No connection available.

meaning something as “Our outside”). Being a grandmother Ans likes to stay in touch with her children and grandchildren. In addition to the telephone, she prefers to communicate with them by e-mail and Skype, because as she explains to me “that is much cheaper, and they can send pictures as well”. The same volunteer who assessed Koos’ sites for potential Wireless Leiden connectivity, now offers the same help to Ans. He motivates his decision by referring to his time as a hobby gardener at “Ons Buiten” some years ago, something he had really enjoyed. Telephone numbers are exchanged, and an appointment is made for the date on which the site survey at Ans’ allotment garden will take place. This time I myself join as well to observe the further appropriation trajectory.

When some days later the volunteer and I arrive at Ans’ summerhouse, she welcomes us with some fresh drinks and some home-baked pastry. The first half hour is spent sitting outside in the shade, while exchanging information on living in Leiden, hobby gardening, and the bird life that can be spotted in this particular place. Clearly, both Ans and the volunteer share some pleasure in spending time in nature. Only after socializing for a while, the volunteer starts to explain to Ans how Wi-Fi works, and unpacks the devices involved in enabling long-distance wireless links.

What is particularly interesting about the story of Ans is the amount of energy she invests in trying to get her summer house connected to Wireless Leiden. Ans is even willing to start a small lobbying campaign amongst the other inhabitants of the allotment gardens in order to mobilize additional support and financial resources. After a week she has even succeeded in assembling of small group of ten people with he same user needs she is facing herself. Together the group is willing to finance the amount of 1200 euros for constructing a completely new Wireless Leiden node located at the allotment garden. In order to research this scenario the volunteer visits Ans a second time, in order to perform additional measurements, this time also from the roof-top of Ans’ summer cottage to see if the new node could be potentially located there (see figure 3.11 on the following page).

Although in this particular example all necessary elements seem to cooperate (Wi-Fi waves, interested potential home users, a motivated Wireless Leiden volunteer willing to help, the availability of financial resources, a suitable location) in the end appropriation fails. The reason for this becomes apparent when I observe the Wireless Leiden board members meeting in which the request by the allotment gardens is discussed. During this board meeting the scenario of building a new node at the allotment gardens is shortly discussed. Quickly the board members decide against the plan. In their view they do no see how the plan provides any gain for Wireless Leiden itself. Or, as they state it “We see no task here for Wireless Leiden.” In their view the ‘allotment garden’ group should arrange their own solution themselves. For example by installing a commercial ADSL access point at the “club house” where the offices of the allotment gardens association is located, and then sharing it locally through Wi-Fi. However, the board members forget to although such a solution might be rather straightforward to them, realizing it requires technical expertise not available at the site of the allotment garden, where people are rather interested

Figure 3.11: A volunteer testing the wireless reception at a site of intended use

in gardening than in wireless technologies. Also, the board does not provide detailed feed back; neither about the reasons for turning down the proposal for financing a new node by allotment garden inhabitants, nor on the alternative solution for this group, probably because they consider it a trivial solution. What struck me while observing the meeting, was that the board members did not take into account that their alternative solution would not work in practice, because of the specific location of the club house at a remote corner of the allotment gardens area, whereas their plan assumed a centralized location of the club house.

To conclude this section: as we have seen connecting homes to the Wireless Leiden collective is no easy job. It involves a lot of work, without any guarantees. Even when prospective home users engage in 'social engineering' activities in order to aggregate resources, this in itself does not result automatically in success. Sometimes additionally lobbying within the board of Wireless Leiden seems required as well. Perhaps seen from the perspective of the Wireless Leiden board, some users (organizational users as sponsors) are considered more valuable for the further development of the wireless network than home users. This particular prioritization of different user needs (combined with increasingly cheaper commercial broadband Internet access) could then be related to the decreasing number of home users over time since the peak during during the first years of Wireless Leiden.

3.4.4 Wrapping up appropriation

What stands out in the appropriation phase of the domestication dynamics of Wireless Leiden as community innovation is that two different types of users emerge. Those two type of users can be categorized as two ideal typical users which I termed *explorers* and *extenders*.[51] The extenders consider Wireless Leiden as a tool for acquiring Internet access. The explorers consider Wireless Leiden as a playground for experimenting with Wi-Fi technology, for them it is more of a toy. Six out ten respondents (Ans, Chris, Dave, Floris, Igna, Koos) exhibit extender characteristics; four out of ten respondents are clearly explorers (Ad, Marc, Rob, Tom). Eventually however, these categories are fluid, just as the boundaries of 'the community' and 'the technologies' involved in the process of community innovation. Sometimes users shift temporarily from being more explorer-like to extender-like, and vice-versa.

3.5 Conversion work

The central question addressed in this section is: *What work is involved in conversion by home users and how do home users display their competence and express themselves as Wireless Leiden user?* To answer this question section I make a distinction between conversion taking place with people who are not

[51] Tor the introduction of the user typologies of explorers and extenders, see Aune (1996); Sørensen et al. (2000).

actively involved with Wireless Leiden, as well as those who are. In both settings we follow users enacting physical interaction in person, as well as electronically mediated interaction taking place on the Internet.

3.5.1 'Ad hoc' conversion

One of the first things I noticed in the stories of Wireless Leiden home users is their enthusiasm if they succeed in configuring a stable connection. Often they are proud of their accomplishment and like to showcase the result of their work to people who are not familiar with this kind of Internet access. Additionally, Wireless Leiden home users are intrigued by the way the technology works in an invisible manner, while nonetheless being reliable, fast and free. For instance, respondent Marc expressed his enthusiasm as follows:

> "It is tremendously nice to say to visitors at home: look here I've got this small box with an antenna and outside over there is a similar box. These things communicate completely wireless, and that is my connection with the Internet. It's real fun showing my own connection. At first I really got a kick out of it. However over time that has become less. [...]"[52]

Because of their enthusiasm about Wireless Leiden as a local, free initiative for Internet access, users like to increase awareness about its existence by recommending it to others. However, this almost religious 'evangelizing work' is often met with negative responses from 'non-believers'. Asked about their experiences with informing others about Wireless Leiden or recommending it, a negative reaction was typical. This quote of respondent Igna is a clear example:

> Researcher: "Do you have the idea many people know you use Wireless Leiden for Internet?"
> Igna: "Gee, well, everyone I know... if people are talking about how to arrange a connection to Internet in our neighborhood, then I mention one can also use Wireless Leiden. Well, they just stare at you with this completely blank look in their eyes."
> Researcher: "You mean, they do not understand what you are talking about?"
> Igna: "Right, not the faintest clue. And then you start explaining what it is. Then the first thing they ask: 'All that is really free? But how is that possible?' And then they start worrying about the danger of radiation."
> Researcher: "They worry about their health because of the Wi-Fi signals?"
> Igna: "Yes, but then I respond that radio waves also travel through the air, even when your own radio is switched off. [...] So to sum up, I can't really say that people react in such an enthusiastic way, that they ask if they can come over at my house to have a look for

[52] Interview with Marc, 2007-04-19.

> themselves how it all works. Or that they express an interest in using it themselves."[53]

Respondent Rob also shared his own positive Wireless Leiden experiences with his neighbor. Howevers his enthousiasm could not convince others of the usefulness of Wireless Leiden, as the following interview fragment conveys:

> Researcher: "You mentioned talking about Wireless Leiden with your neighbor, is he connected as well?"
> Rob: "No, he is using Orange. But that is because he wants to download tremendous amounts of data, and he thinks Wireless Leiden is not fast enough, you know. But then I replied to him, yes of course, but you have to consider it is free, and it is just not meant for downloading huge files. You need to keep the intended purpose in mind."[54]

Another example of this pattern of 'unknown, unloved', shows a complete lack of interest, even from one user's direct family. In the words of respondent Ad:

> Ad: "At that time I wanted to try to send files to other people over the network. And then it's nice if you know other people who are using it too. But I had no acquaintances with whom to connect. At the time everyone was calling me a nerd just because I had such an antenna on my roof. Well anyway, it wasn't that bad actually."
> Researcher: "Who were those people? People from the neighborhood?"
> Ad: "No, no, people from around here. But more my family and relatives. They would ask: 'What are you up to this time? Busy again with that technical stuff?' And then they would laugh and loose interest."
> Researcher: "And were visitors asking about what is the purpose of that thing over there?"
> Ad: "Yes, they would ask what it was and why it was there. But after a while most knew what I was doing. So now they no longer find it strange. However, certainly in the beginning, when I was fiddling around in FreeBSD and so on, they'd be completely clueless."
> Researcher: "And your wife and kids, do they grasp what you are doing?"
> Ad: "No, they don't get it. They have some experience with Windows, but even then. Because at school you don't need to learn this kind of computing; they just learn things from each other. But the moment my kids see a command line prompt, they immediately pull out."[55]

Respondent Marc experienced similar responses of lack of interest, although this person seemed not upset about it at all:

[53] Interview with Igna, 2006-02-33.
[54] Interview Rob, 2008-07-28.
[55] Interview with Ad, 2008-08-01.

> "Over time I have recommended Wireless Leiden to several other people; but usually they do not listen anyway. Furthermore I have encountered only a few people in my surroundings who have enough technical know-how to use it. Nowadays a lot of people just don't see any purpose for Wireless Leiden anymore, because they already have a cheap and fast ADSL connection. But that's okay with me. The less people use Wireless Leiden, the faster my own node is. In the weekend I really notice that it becomes a lot slower when others use it as well."[56]

A second theme that stood out was how users expressed their identity as Wireless Leiden users by deploying it as way to show off their skills, knowledge and competence; both technically and socially. Research literature on free and open source software development names the following motives for actors' participation: acquiring new skills, competencies and knowledge (Ghosh and Glott, 2002). Another often named motive is reputation building, which can also be useful when applying for a new job. Although all of these motives mentioned above were cited by those involved in the emergence of Wireless Leiden, I have observed them with home users as well.

One Wireless Leiden home user who is currently unemployed made a very explicit choice to start using Wireless Leiden as a valuable way of spending his free time, while simultaneously acquiring new skills, which could improve his value on the job market. When writing job application letters, this user explicitly mentions Wireless Leiden:

> Researcher: "Do you think that by using Wireless Leiden you have learned things that could be useful in your next job?
> Rob: "Yes."
> Researcher: "Would you mention Wireless Leiden on your curriculum vitae?"
> Rob: "Yes, as a matter of fact I've already put Wireless Leiden on it. For me it's a way to show what you are all capable of, in addition to your work related experience."
> Researcher: "And how do you think this will work in your advantage?"
> Rob: "Well, I don't think most people will really look at it. But that doesn't matter. Those who are interested, will do a quick search on the Internet. And then they could think, oh well, what's he doing there? [...] When they find out it's a volunteer-run organization, then their first impression on the overall picture will be positive. At least, the first time I saw the Wireless Leiden website, it all looked like a very professional organization to me."[57]

Something similar was observed by scanning through other Wireless Leiden users profiles on professional networking websites such as Linked-In. By chance

[56] Interview Marc, 2007-04-19.
[57] Interview Rob, 2008-07-23.

I found out about this linking activity, when one of the people whom I had interviewed sent me an invitation to become part of his contact list on LinkedIn. Only after I subsequently accepted this invitation I found out how many Wireless Leiden users and volunteers had added each other to their personal work-related profile. During interviews no one had mentioned this way of deploying their status as Wireless Leiden user in order to increase their on-line CVs. Some people also gave others professional recommendations such as "this person is really knowledgeable on wireless networking" or "really great person to cooperate with" or "an extremely fast thinker".[58]

3.5.2 Conversion in Wi-Fi hobby communities

The last type of conversion to other Wireless Leiden non-users I encountered was mostly taking place on-line, or to be more specific, in on-line forums or on wireless community networking related mailing lists. One specific Internet location where Wireless Leiden users expressed their expertise as users took place on a website called 'WirelessNederland'. This website consists of a combination between a front-page filled with Wi-Fi related news, events and product reviews. However, the most active part is the forum section where Dutch speaking Wi-Fi hobbyists located in the Netherlands or Belgium post messages containing specific questions or messages, to which other registered members can post a reply.

Often people post here to ask advice or help solving specific technical problems. By answering questions people can show their knowledge, and also earn 'kudos' from the community by building a reputation as being helpful towards others.[59] However, most discussions would often only be of interest to people who were mainly interested in Wi-Fi technology itself, and not primarily in using it for day to day tasks. Examples of popular topics of discussions are hacking to firmware of cheap Wi-Fi routers in order to increase functionality or transmitting power, and exchanging experiences with constructing all kind of different antenna designs and their performance.

As a spin-off of this forum, a yearly 'camp event' was organized, so people had the opportunity to meet each other in person and get to know each other in another setting that allowed for more diverse ways of social interaction than just exchanging text messages. Just to give a short impression of the character of this event: the highlight of the camp was the so-called 'yearly antenna contest' in which people — exclusively male — were competing against each other to

[58] All quotes from LinkedIn profiles of Wireless Leiden volunteers.

[59] Actually this forum is another example of a commercial Wireless Leiden spin-off, initiated by a user-entrepreneur. The website was started by a (former) Wireless Leiden user and volunteer (Mark Boos) who was irritated by the fact that the Wireless Leiden website was lacking a proper web-forum and then decided to initiate one himself. However, he started this project outside of Wireless Leiden, by registering his own domain name. Also starting under the name WirelessNederland, he cast his net much wider than restricting it to the Leiden region only. Additionally, he allowed shops selling wireless commodities the possibility to place advertisements, and thus also providing himself a way of earning money as well.

test whom had been able to construct the aerial with the highest gain in order to bridge the potentially largest distance.[60]

Not only 'hobbyists' gathered at this forum, home users posted messages as well. Nonetheless, often when home users raised questions that were specifically about the wireless network in Leiden, friendly Wireless Leiden volunteers would instead of answering their questions, encourage them to enlist to the Wireless Leiden user mailing list, and visit one of the monthly open meetings or ask for advice at a weekly free consultation without appointment. In this way, home users discussing their experiences with Wireless Leiden were repeatedly encouraged to do so within the boundaries of Wireless Leiden itself.

And that brings us to the next subsection in which we follow home users, and their conversion work within the confines of Wireless Leiden.

3.5.3 Mediated conversion

In addition to *ad hoc conversion* enacted by home users towards family, friends or circle of acquaintances, in this section the focus is on *mediated conversion*. The difference here is that the conversion work by actors to express themselves as home users is structured and mediated by Wireless Leiden. Therefore home users not only express their identity as users, but in the act of doing so, they also become an element of Wireless Leiden itself as community innovation. So the central question then becomes: how does Wireless Leiden mediate conversion work of its home users?

To give an example of mediated conversion let us have a look at the following scene. It might seem similar to the "join and connect!" scene described earlier, however there is one significant difference. This time not only volunteers appear front-stage, but home users as well.

"Join and get connected!" — version 2

Leiden, 11 January 2005, Saturday 10.30, public library Stevenshof. Open meeting for (new) users. Wireless Leiden information meeting, targeted towards prospective Wireless Leiden. The following text announced the event: "This meeting is intended for anyone who would like to know more about wireless networks, what it requires and what you can use it for. [...] Wireless Leiden volunteers give presentations and advice." However during the meeting not only Wireless Leiden volunteers enter the stage. Mid-way the meeting a new speaker is announced as "and now Igna will tell about her experience as a Wireless Leiden user. In lay language she will tell what she did to connect her home to the wireless network, the difficulties she encountered and how she solved those". Igna stands up from her seat to stand in front of the audience and starts her talk with the following introduction.

[60] I abstain from any 'Freudian' interpretation whatsoever of such type of contest. Nonetheless there is clear link of technology as identity projects, more specifically of enacting male gender by displaying virtuous mastery over technology. In chapter 4 (Care work) I analyze this trope into further detail and more references to relevant literature are provided.

> "Before I start this talk, I have to warn that I do not really know that much about Wi-Fi. So if you have any technical questions I probably can't answer them. What I do know and will tell you about is my personal experiences with Wireless Leiden. When I encountered some problems with a dropping connection, and asked help to solve this, people pointed me to an on-line document called 'Debugging connection'. Although I tried to follow all the steps it described, it didn't work for me. The text contained mostly words or computer commands I had never seen before. And additionally, as I only found out later, some necessary things were not even explicitly mentioned, but were supposed to be common knowledge. Luckily, a volunteer, Dirk, was willing to help me solve my problems. But as a favor in return, he asked me to write up a new version of the "Debugging connection" guide, but now in language anyone would be able to understand. Well unfortunately, I never found the time to write it all up. But Dirk kept bugging me, and as an alternative he asked to give a talk instead, to which I agreed. That is the reason for my talk here today. So I can pass on my own experience on how to use Wireless Leiden and stay connected."

Then Igna continues her talk by telling on how she discovered Wireless Leiden for accessing the Internet, how she went to a local store who helped her choosing the right equipment to connect. And then she describes in detail how during spring she suddenly lost connection with the network. And how with help from the mailing list, the how-to document and the visit from Dirk she managed to recover to a stable connection again.

At the end of the meeting a small group of people line up to have the chance to speak to Igna personally. She shortly answers some questions, but mostly refers people with their questions to the Wireless Leiden volunteers present at the library. Additionally, she also helps a mother with a small child, who had brought her laptop computer with her, to configure the settings in the right way for connecting to the network. After a few minutes the woman is able to surf the web via the Wireless Leiden node installed on top of the library.

3.5.4 Communification

In the previous scene we saw how the expertise of being a 'non-expert' (in this case as a home user), was being feedback into Wireless Leiden.[61] In this way home users become an active element of the community innovation. Although Igna never chose to become an 'official' Wireless Leiden volunteer, for the members of the audience there is no question that Igna is an integral part of the community innovation. They do not see any distinction between Dirk, an

[61] Hounshell (1975, 159-160) presents an interesting historical case on telephony innovation which shows how sometimes being an expert can actually become a disadvantage: "In short, Gray was an expert and a member of a community of experts. Paradoxically, he was handicapped by these credentials. [...] The story of Bell should make us appreciate (unfashionably, in our day of scientific R&D) the role of 'amateurs' in introducing dramatically new technologies."

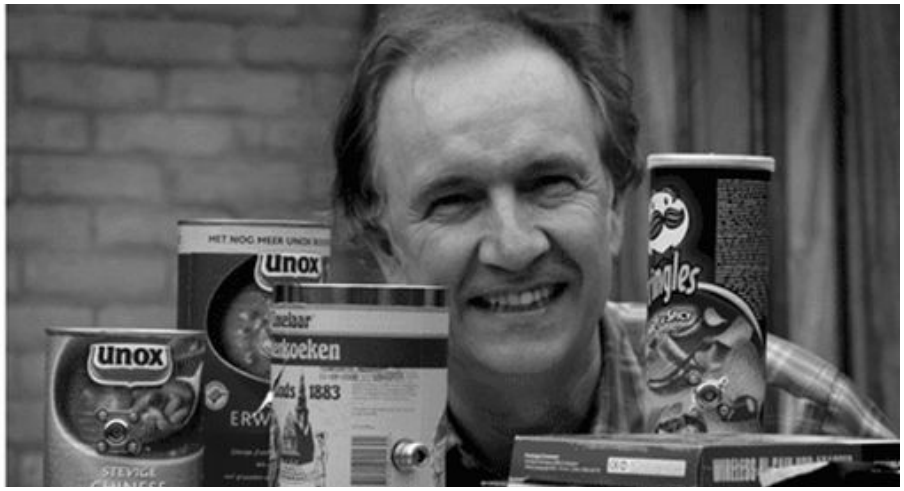


Figure 3.12: Photograph from newspaper article on Rob's cantennas

official volunteer, giving a presentation, or Igna, a home user; to them both are knowledgeable about Wireless Leiden. At the end of the meeting many people even preferred talking to Igna, because of her ability to answer questions in a way they can understand and relate to.

The experience of Igna exemplifies how Wireless Leiden incites home users to feedback their experiences to the community via communication channels offered by Wireless Leiden. As we have seen in the previous scene this can be in the form of 'telling tales'. A method for sharing local knowledge on solving technical problems, that is also observed to be effectively used amongst photocopier repair personnel.[62] But 'local use expertise'[63] is feed back through other mechanisms as well.[64] Another example is via the construction of so-called 'how-to guides'. Another user, Rob, has taken up this activity as manner of 'doing something back' for Wireless Leiden. Putting his previous job experience with writing professional documents for ISO 9001 certification, he has produced an increasing series of documents targeted specifically at home users. These manuals are then published on the Wireless Leiden website. In this way, knowledge is aggregated in the form of manuals, and by publishing them as digital documents on a website, enables their further circulation.

An example of this is when one of Rob's manuals, this one targeted to inform people on assembling ones own cheap 'cantenna' constructed from an empty soup can, was picked up by a local journalist. This journalist then decided to

[62] See Orr (1990).

[63] Something von Hippel would describe with the concept of "sticky information" (von Hippel, 1994, 1998)

[64] Starting-points for a further exploration of communification as part of domestication dynamics, are offered by the notions of "community of practice" (Draaijer, 2008, 13; Amin and Cohendet, 2004; Wenger, 1998) and the related notion of "networks of practice" (Brown and Duguid, 2001,Wasko and Faraj, 2005).

devote a small article about how one can obtain free Internet easily and cheaply by means of re-purposing a tin can into a Wi-Fi antenna. However, when this journalists contacted the author of the manual, Rob, for an interview, he did not really feel he is the right person to do an interview with. Only after one of the board members insisted he should give an interview, Rob finally agreed. In this way via a newspaper publication, Rob, as a home user became a representative for Wireless Leiden as whole (see figure 3.12 on the preceding page).

What makes Wireless Leiden interesting, is the fact that as a project it recognizes the special local expertise of home users.[65] Not only that, home users are asked, based on reciprocity in return for free Internet access, to feed back this local knowledge into the community innovation. In order to do so, various mechanisms are offered, ranging from giving talks, to writing documents, attending meetings or answering e-mails on a specially for this purpose initiated 'user list'. This process of home users becoming part of the community innovation is what I propose to label as *communification*. Communification is an inherent element of domestication of community innovation.[66] When studying domestication of community innovation, it seems to me that we cannot grasp the complete process of the stabilization of use in everyday life by focusing on the community innovation entering home users' houses, without also taking into the account the reciprocal and reverse flow of home users into the community innovation.[67]

3.5.5 Wrapping up conversion work

The main point that stands out in the conversion of Wireless Leiden as community innovation is the realization and recognition of the home user as 'local use expert'[68]. Home users are actors who have experience about their particular specific local use practices; or reframed in Innovation Studies vocabulary: 'sticky information' to which the makers of Wireless Leiden do not automatically have access.[69] What sets community innovation apart, and what determined partly the success of Wireless Leiden, is the active involvement and increasing level of inclusion of home users into the community. In this sense there is not only a feed back loop for information, but also an aggregation of knowledge, mediated via Wireless Leiden and its mailing lists, wiki, website, how-to guides and local meetings. In this sense the locally developed knowledge and expertise does not only remain in bodies or heads, but also is actively translated and transcribed into (im)mutable mobiles that can further circulate through the

[65] For an analysis of the expertise of 'the perpetual novice' see Davis (1997).

[66] An interesting study in this regard is on community "joining scripts" by von Krogh et al. (2003) or Becker (1953)on how "becoming a user" involves a social learning process of which becoming a member of a collective is an essential element.

[67] In material-semiotic terms one could observe that only users properly translated in 'network-actors' can become fully connected to a community innovation actor-network.

[68] I use the notion of local use expert in another way as Stewart (2007)introduced the notion of local expert. In the following chapter (Care work) I devote more attention to this concept and the similar notion of warm expert, developed by Bakardjieva (2005).

[69] For the notion sticky knowledge see von Hippel (1994).

network, and if necessary further adapted; and even travel outside the confines of the community innovation in which they emerged enabling spin-off opportunities.

3.6 Conclusions

Studying the domestication of community-based innovations resulted in the following insights.

In the first place, we learned that even community innovation, which can be obtained and used freely, has to be actively promoted. Whereas commercial innovations are diffused by a process called "marketing" via the 'market' as infrastructure for circulation of information and consumables, in an analogous manner an active strategy should be devised to inform users. However, circulation of information and devices is arranged in other ways: partly trough the 'news', partly via the Internet, and partly via the market as well, through the sales of Wi-Fi devices which Wireless Leiden can hook into.

In the second place we encountered different types of domestication dynamics based on different user-technology relations. In this chapter I distinguished *extenders*, in this case usually Wireless Leiden home users, from *explorers*, usually Wireless Leiden volunteers.

In the third place we learned the importance of recognizing the expertise of the home user, as an "experience" expert. Being able to feed back that specific expertise into the community innovation in order to create a social learning feedback loop is a crucial aspect of domestication work in the process of community innovation.

Fourth, a specific characteristic of the domestication dynamics of community innovation is what I termed *communification*. In addition to the community innovation technology being "tamed" by a home user, an inverse movement takes place in which a home user is being "encultured" into the community innovation. Underlying motives for actors to engage in communification is the reciprocity of the gift-based economy of community-based innovation. Home users are expected to become actively involved in return for free access and free support.

Finally, we learned that domestication of community innovation involves quite a large effort. Both within the 'makers' sphere of the community innovation as well as within the users' sphere. Key for understanding all this domestication work, is that it is a distributed process that can not be reduced to individual user-artifact interactions. Domestication of community innovation is an inherently collective process, taking place on the aggregated level of the community innovation as hybrid collective. However insightful the different analytical dimensions of the domestication approach might be, in practice domestication is no neatly separated process. As much as community innovation consists of fluid technology, the domestication dimensions itself are also fluid, in the sense that there are no clear boundaries between the dimensions of commodification, appropriation, conversion and communification.

The domestication dynamics encountered in the case of Wireless Leiden to a certain extent might be generalized to other cases of community innovation such as Wikipedia, Linux or Project Gutenberg. Within community innovation practices there is always a certain tension between keeping different types of users content: on the one hand explorers, and on the other hand extenders.[70] How to balance the different needs of both user types at the same time is an important issue. Those who govern community innovation have to be aware of this, and devise a strategy for. An often applied solution is branching off so-called 'stable' branches and more fluid 'development' branches to address the different needs of different uses. In this way 'packaged' ready-mades are available for home users, while the source-code to tinker with is also available for developers. This seems an elegant solution to address the different needs of various users, based on differences in focus within user-technology relationship, although the case of Wireless Leiden illustrates that this branching strategy is not always required. The following chapter further addresses the intimate relationships between users and technologies when we follow the actors involved in care work.

[70] After a certain period of initial development, specific local arrangements emerging from community innovation can reach a certain level of functionality and stability, often another type of 'users' appears as well, those who want to 'package' the community innovation and distribute it as consumables via markets. However, this process has not been focused on in this chapter. Nonetheless, the availability of packages versions of technologies resulting from community innovation, might be an important aspect for facilitating its domestication by extender type of users.

Chapter 4

Care work

> "Against the flow of this constant entropy, maintenance people must swim always upstream, progressless against the current like a watchful trout. The only satisfaction they can get from their work is to do it well. The measure of success in their labors is that the result is invisible, unnoticed. Thanks to them, everything is the same as it ever was." Brand (1994, 130)

4.1 Introduction

Wi-Fi technology inspired several local communities of citizens to construct their own local, often city-wide, ICT infrastructure. Stories about the rise and growth of these community innovations enjoy a growing interest, but how about the less heroic, but just as important work of maintaining and keeping these community innovations work? The central question of this chapter is how community innovations are made and kept stable by maintaining existing connections between the different elements of the hybrid collective. The work involved in this process I label as care work. I analyze how this care work is distributed over the hybrid collective by delegating responsibilities to its various actors and actants. The main actors engaged in care work are in order of appearance in this chapter: (a) home users, (b) active volunteers, (c) technologies. However before I delve in the empirical study and theoretical analysis, I will first look into the relation between the stabilization dynamics of innovations and the role of care work.

As we have seen in the previous chapters, innovation is a complicated process. And the complexity does not end after alignment and domestication. In effect, due to their structurally open and fluid designs, community innovations are usually in constant need of repair. As such in instances of community innovation more caring by humans is necessary than in cases of commercial innovation. Usually this is reinforced by the prioritization of use value over economic value. Once an instance of community innovation has been set in

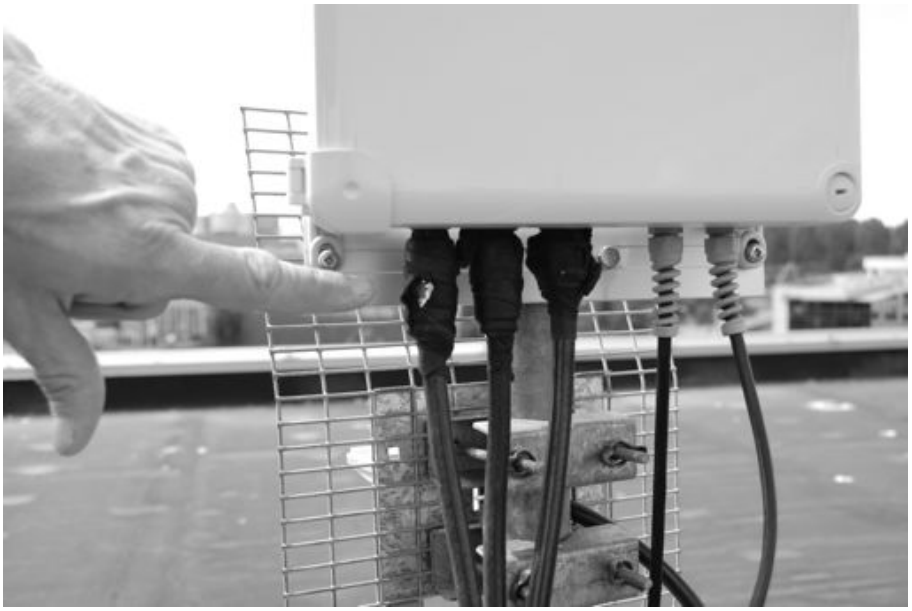
motion, and things sort of work in the form of quick-and-dirty solutions, proof-of-principle implementations or experimental setups, the further extension of such configurations to a state generally useful for home users, and then subsequently keep it in such state, requires strenuous, real-time involvement. For the hybrid collective as a whole to be able to withstand forces of resistance over time, connections between its constituting elements need to be continuously monitored, maintained and, if broken reconnected. Or to quote Graham and Thrift (2007, 5) who observe a general tendency towards constant decay of the material world surrounding us:

> "Moisture gets in. Damp hangs around. Ice expands joints. Surfaces wear thin. Particles fall out of suspension. Materials rot. Insects breed. Animals chew. All kinds of wildlife war with all kinds of fabric. Humans make errors."

Of course, elements of nature battle with all kinds of materialities regardless of the way in which they have come to life or whether they serve a commercial or communal purpose. For those involved in Wireless Leiden, the continuous breakdown of connections between network-elements is primarily of practical instead of theoretical concern. In the case of Wireless Leiden the causes for disconnections within the collective are numerous and ceaseless. Just to sum up some disruptive events observed first-handed: volunteers get chronically ill or die, move to other cities or emigrate to other continents, lose interest or simply disappear without notice, house owners offering accommodation for Wi-Fi nodes relocate, buildings get demolished, birds pick through vulcanizing tape, dowels get loose, the wind blows aerials in the wrong direction, plugs mysteriously get unplugged, dust accumulates, power supplies burn out, hard disks fail, software crashes, files get corrupt, metals rust, rubbers become brittle, and 802.11b radio links deteriorate due to increasing interference by the increasing popularity of Wi-Fi. Without constant care for maintenance and repair, connections turn into disconnections and collectives fall apart into isolated pieces (see figure 4.1 on the facing page).

Strikingly, dominant innovation discourses do not reflect the relevance of maintenance and repair at all. There even seems a tendency to assume that once innovations have stabilized in local settings their state will keep immutable. The underlying assumption here is that once innovations have been implemented in local settings they will keep correctly functioning all alone and until the end of time. This is what I call the myth of the autarkic artefact. Individual technologies can never function in useful ways without infrastructures of support. Technologies never work 'just by themselves', and even if they seem to do so at a specific location, this state is never more than a temporary snap-shot creating the illusion of stability, however seen over a longer period of time, this state will irrevocably change. This myth leads to a blind spot for the constant caring by humans for technologies. As much as we cannot understand society without "the missing masses" of technologies (Latour, 1992), I will argue that one cannot understand advanced machinery

(a) The wind loosened a peg of an antenna mast mount.



(b) birds pecked holes into protecting vulcanization tape.

Figure 4.1: The results of forces of resistance battling outdoor equipment.

and technological infrastructures without "the constant care" of humans.[1] A Wireless Leiden volunteer has formulated this insight succinctly: "network nodes are just like living beings and need attention from humans once in a while."[2]

This chapter aims to debunk this myth of isolated technological autarky by showing the relevance of care work in action for innovation. The gap between the role and importance of care work in innovation practices and its virtually complete absence in innovation theory forms exactly the theoretical terra incognita this chapter aims to explore. Care work, taken as the overarching set containing elements such as cleaning, monitoring, diagnosing and repairing, cannot be separated apart from the process of innovating, as it is an inextricable part of it. I will elaborate on the various types of care work that arise within such volunteer-based community innovations, and analyse how this work is distributed over the hybrid collective by delegating responsibilities and tasks to its various actors, humans as well as non-humans.

The argument of this chapter is structured along the following four steps: First, I will argue the importance of care work for (successful) innovation based on the scanty socio-technical literature on maintenance and theorize the relation between the stabilization dynamics of innovations and the role of care work. Second, I will explore empirically the various care arrangements in the case of Wireless Leiden based on interviews, observations and document analysis. The third step is an analysis of and reflection on the empirical findings on care work within Wireless Leiden looking for underlying explanatory dynamics: how can we understand what actors drive to engage in this care work? Finally, this chapter will draw lessons from the case and discuss the more general challenges of organizing care in community-driven innovations.

4.2 Conceptualizing caring

Gaining a better understanding of care work, the first resource is in the literature. However, there is only a sparse availability of socio-technical literature on this theme. A few publications — framing the issue in terms of maintenance, repair or articulation work — stand out: Orr (1996), Edgerton (1999, 2006), and Graham and Thrift (2007), all make a case for putting "maintenance" on the research agenda. Henke (2000) even makes a plea for the development of a "sociology of repair". Some authors explicitly state that knowledge of maintenance is "a part of the map which experts rarely look at" Pacey (1983, 50), possibly because as a theoretical theme it is "neglected by nearly all commentators as somehow beneath their notice" (Graham and Thrift, 2007, 1), or as Edgerton (2006, 77) states: "[M]aintenance and repair are matters we would rather not think about. [...] The subject is left in the margins, often to marginal groups."

[1] This insight was developed upon the work of Leigh Star on infrastructures; for instance Star 1991.
[2] Quote from message on Wireless Leiden Volunteer Mailing list, 2009-03-15.

Usually care work is studied in professional environments enacted by paid technicians, repair, service or support personnel (e.g. dealing with maintenance of software, information technology, photocopiers, airplanes, railroads or nuclear power plants). However, only a small subset of studies conceptualizes maintenance as work that is inherently socio-technical by character involving both the successful management of and interaction with artefacts as well as people. Some notable examples of studies primarily aimed at the topic of maintenance, consists of ethnographies of repair as technical work (Harper, 1987; Orr, 1996), anthropological accounts of maintaining technologies in "the South" Pacey (1977a), or historic studies on the relevance of maintenance (e.g. Edgerton, 1999, 2006). All in all, the authors of the few sources that exists, although very diverse in discipline of origin, empirical domain and conceptualization, virtually all agree that maintenance is an under-studied, under-theorized object deserving more interest from the research community in general.

Remarkably, one major strand of literature is missing: Innovation Studies. As a relevant theme, maintenance is absent in the academic literature on innovation (except for Rosenberg, 1982). A striking example is the standard work on "diffusion of innovations" by Rogers (1995), in which maintenance is not included in the subject index (see pages 543-550). Another clear example is van de Ven et al. (1999) on "the innovation journey", a book in which the word maintenance was also considered not important enough to include in the index because supposedly stabilization by maintenance is not considered as part of the wider innovation dynamics. I will however localize maintenance as an inextricable part of innovation, as poignantly phrased by Suchman (2002):

> "[I]f technologies are to be made useful, practitioners of other forms of work must effectively take up the work of design. Integration, local configuration, customization, maintenance, and redesign on this view represent not discrete phases in some 'system life cycle' but complex, densely structured courses of articulation work, without clearly distinguishable boundaries between them."

While indeed in dominant discourse on innovation, maintenance is not considered to be part if it, this chapter aims to prove the opposite.

Research literature on maintenance performed by unpaid amateurs, hobbyists, hackers or volunteers is even more sparse. Current literature has mainly focused on maintenance work of on line (innovation) communities by managing the infrastructure for communication and information sharing as well as maintaining the community (Hansen et al., 2007). Two strands of literature can tell some interesting and relevant stories in this respect:(1) free and open source software development and (2) technologies used in poor economies such as common in the South (Africa, India, South-America).

In the research literature on free and open source software (FOSS) maintenance of the source code (for instance cleaning up and documenting) is considered to be part of software development. Maintenance in the form of bug fixing is inherently distributed as Linus' Law states: "Given enough eyeballs, all bugs are shallow". Meaning that in addition to developers also users of free

software are part of the “bug-fixing” process. (Raymond (1999); Shah (2005)). In this strand of literature, maintenance tasks are often not explicitly labelled as maintenance work (von Krogh et al. (2003)) although the description of tasks covers maintenance activities such as “bug fixing”, “bug reporting” or “suggesting improvements”.

A second source for understanding collective maintenance is offered by literature on experiences with sustainable maintenance of water hand-pumps in remote villages as source of clean drinking water (see Pacey (1977a,b); Morgan (1990); de Laet and Mol (2000)). One helpful notion originating in this strand of literature that resonates with community maintenance as in the case of Wireless Leiden, is ‘Village Level Operation and Maintenance’ (VLOM). This notion emerged in the nineteen seventies as a means for delegating maintenance and operation work from a centralized authority to the distributed communities of hand-pump users, with varying success.

As literature on maintenance work is sparse, and not able to provide a theoretical framework, I will use actor network theory to conceptualize innovation and care work. This framing helps us understand how the variety of work that needs to be done to maintain an innovation ‘working’ is distributed over the network. The ‘material-semiotic’ approach (Akrich and Latour, 1992) offers valuable insights on how to include technology itself in the analysis of maintenance processes. Relevant for this chapter is the way this approach conceptualizes innovations as heterogeneous networks consisting of both human as well as non-human elements. If we conceptualize innovation as a process of assembling networks that are locally situated and are robust enough to withstand forces of resistance without falling apart into its constituting elements, then work is necessary to monitor (‘preventive maintenance’) and reconnect (‘curative maintenance’ and repair) in case of disconnection the multitude of links between all the different elements. This means that “keeping things the same” is an innovation itself, as Suchman and Bishop (2000) argued. Networks are no stable entities; at best they are in a state of dynamic equilibrium. For observers the network-character results of processes of innovation often have faded away into the background, and instead the innovation-in-use becomes thought of as a stable artefact; a “configuration that works” Rip and Kemp (1998). However, this stability — often thought of in terms of standardization or black boxing — is not a natural state, but an effect of continuous hard work. A better understanding of this state, is that of a ‘dynamic equilibrium’; a state in which the amount of link breakage equals that of link repair and reconnection.

Community innovations, yielding fluid technologies with a structurally dynamic and distributed character, are a challenge to maintain. Both involved insiders from within innovation communities as well as distant outsiders perceive the stabilization of community innovation as potentially problematic. As there is neither a product, nor a ‘service level agreement’, this evokes the question of “the geography of responsibilities” (Akrich, 1992) for taking care of maintenance and repair.

The maintenance challenge for community innovation becomes especially pressing when hybrid collectives contain increasing numbers of differing actors

and actants. Those trying to successfully steer this process, often sooner than later discover that scaling up 'nicely', involves a skillful managing of complexity and contingency. Increasing size, scope and sophistication lead to emerging network effects which are non-linearly related to the underlying growth and thus cannot be reliably and precisely anticipated. What is striking when studying community innovation practices in detail, is how much care work is actually taking place in order to keep community innovations stable and behaving orderly, without any (substantial) involvement of paid professionals or commercial service providers.

In the next sections I focus on how Wireless Leiden tried to cope with the new and demanding challenges of monitoring, maintaining and repairing a highly distributed, heterogeneous and fragile, wireless infrastructure. I zoom in on the care work of network nodes as their functioning is central for a stable and reliable infrastructure. Furthermore, I distinguish two different involved groups of human actors: the home users and the usually more experienced and knowledgeable volunteers. In the next two sections I address for both groups the following questions: first, what type of care work is performed by home users and volunteers; second, to what extend is care work delegated to non-humans and third, what drives home users and volunteers to engage in all this work and accept the responsibility for maintenance?

4.3 Caring for technologies

Building nodes from scratch is one thing, but actively maintaining them is clearly another thing and usually something most of the original creators are not really that much interested in once the interesting technical puzzles are solved. One of the long-time board members of Wireless Leiden expresses his experiences with the volunteers as follow:

> "Communities such as Wireless Leiden are often initiated by technical enthusiasts. Their focus is primarily on tinkering. When ninety percent is working, then their curiosity is satisfied and they start tinkering with something new. Users are conceived as something that is only troublesome and inconvenient, because they only know Microsoft Windows and they ask stupid questions."[3]

This lack of interest of most technically motivated volunteers in 'routine' maintenance and repair work of individual Wireless Leiden nodes and the network as a whole, is something many Wireless Leiden participants have identified as a potential problem for the further growth and development of Wireless Leiden. This does not mean that technical volunteers are not interested in maintenance or repair per se, as we will see in the following section when I zoom in on their involvement in care work. However, most technical volunteers are just not interested in practices in which their technical competences are not challenged. As a solution for the lack of resources for this type of work a strategy for delegating

[3] Interview Huub Schuurmans, 2005-10-09.

tasks and responsibilities to home users emerged. Over time a local community care arrangement developed in which home users fulfil important functions for the stabilization of the network. The core element of this care arrangement was the linking of individual Node Adoption Volunteers (NAV) to individual nodes.[4] This hybrid user-artefact entity proved to be central in the shaping of a stable and reliable network. Below I will first describe how the Node Adoption Volunteer emerged and what type of care work is performed. And second I will address the question how and why home users engage themselves in these activities.

4.3.1 Taking adoption seriously

Home users collectively function as a distributed system for monitoring and failure reporting the 'health' of the network. If some part of the network no longer functions correctly, a home user connecting to a specific malfunctioning node is usually the first to note the erratic behavior. Due to limited resources and interest of expert volunteers, maintenance is only initiated after a user has filed a failure report by sending a message to the user mailing list. It is then read by others who try to help the original poster if the problem is at his or her side of the connection. Otherwise the problem is forwarded to the volunteer mailing list where more knowledgeable volunteers then assess the problem, and if necessary and with enough time available, try to fix it. This particular way of users as monitoring system is what one interviewee called the so-called "whine model". Only when home users start complaining, one of the volunteers assesses if action is necessary. One volunteer, who started becoming more actively involved in Wireless Leiden by being an active 'problem reporter' explains how the practice of reporting and repairing works:

> "At the moment it is a sort of whine system. That means that if something is broken, people will start whining, and only then you have a look at it. So I am not pro-actively monitoring all kind of things, it is more a kind of passive system. This notion of whine system is something that is widely used by people responsible for system administration."[5]

However some home users became frustrated by this so-called whine system, and the way in which they were configured as 'soreheads', and a discussion about systematically bringing home users into action to the greater good of the Wireless Leiden network was initiated. Collectively and in a bottom-up manner during this discussion a specific new role within the community was invented: the so-called 'node adoption volunteer', abbreviated as NAV. Also note how by becoming active as NAV a home user is communificated (see chapter 3) from being a 'mere' user into an actual volunteer, indicating the increased inclusion into the Wireless Leiden community.

[4] This type of users was already shortly described in chapter 2 in the subsection on 'the maintenance user', see page 40.

[5] Interview Marc, 2007-04-19.

Interestingly enough in this case the term ‘adoption’ was introduced to describe the relation between active home users and ‘their’ Wi-Fi nodes. Adoption implies a warm undertone of respectfully taking care of a ‘child’ who from now on will be a member of the family. The adoption metaphor fits in with the locus of the community. The ‘adopted’ that needs help in this case is a geographically nearby located Wi-Fi node. The adopter is the home user who relies on the node for its Internet access. The ‘family’ is not the household, by the wider Wireless Leiden community.

This new user role emerged during a discussion on the Wireless Leiden mailing list that started in February 2004 when home user Marc decided to add a more positive note to one of his regular e-mail complaints about the breakdown of one of the Internet gateways:

> “I feel like the aggrieved consumer who can only complain ... that is not the position I want to take up. I would like to contribute too, but when I look at the list of vacancies I become disheartened by the level of expertise that is required: project leaders, people who know the ins and outs of TCP/IP.”

What this user implicitly asks is: I would like to play an active role in the community innovation by contributing something back to Wireless Leiden, but I do not know how, lacking the technical expertise and skills of the “official” Wireless Leiden members. With this post Marc sets of a cascade of e-mails in which the “usefulness” of user-contributions is discussed. After several invitations to join the weekly “technical meetings” or to subscribe to the “systems administration mailing list” one of the “technical experts” further sparks the discussion by ironically stating

> “[U]nfortunately it is not attainable that every user can contribute something to the network, except for additional data traffic ;-).”

Another Wireless Leiden volunteer responds:

> “I do not agree with you on this, because I do think anybody can contribute something. You do not need any understanding of computers. For example organizing information meetings or updating the website are important activities. One of the most time consuming jobs is powering nodes on / of. This is something that does not need to be done very often (usually such a machine happily runs for half a year or even longer), however sometimes it is the only solution to bring it back to life. Perhaps it is an idea to let users adopt the specific node they are connected to, in order to monitor its performance, report problems or if necessary reboot the machine on location. Additionally, they could do a yearly inspection just to check if everything is still well connected. The advantage is that users live near by and immediately notice problems in case of a malfunctioning. This is not difficult to do. It requires no special expertise and would save the volunteers a considerable amount

> of time. And above all: this way even more people are actively engaged with the network."

In the following days several home users volunteered to adopt a node, the official term "Node Adoption Volunteer" is invented, and in April 2004 the first "node-adoption group" meeting takes place. One person summarizes the 'gift economy' from the home user's perspective:

> "I would like to invest some time into this so I can do something in return for the Wireless Leiden network I am using."

Since causing the stir about nodes needing help in the beginning of 2004, Marc gave several presentations about his experiences and is still taking care of keeping 'his' node Cetim properly connected. In this way, the communification (that is the involvement of an individual in the innovation community) of this particular home user into the Wireless Leiden network took place parallel to the domestication of Wireless Leiden into the user's home. These reciprocal bonding mechanisms are central in understanding the dynamics of the growth and stabilization of a communicity innovation. But keeping the community innovation stable and robust involves a lot of care work. To better understand what the care work of a node adoption volunteer in practice entails, I accompanied Marc on one of his maintenance operations:

> Leiden, April 12, 2007. An ordinary Thursday evening. While it is raining outside, I accompany Marc — a man somewhere in his early forties — on his way towards the Hooglandse Kerk, one of the old buildings that grant the historical city-centre of Leiden its picturesque quality. After borrowing the church key from the nearby-housed parish clerk, Marc unlocks one of the side entrances. Inside, he walks straight up the narrow and creaky stairwell to the top of the bell tower. Once arrived on the bell platform he switches on his torchlight enabling him to locate the aim of the trip: three brightly-yellow painted military ammunition boxes connected by heavy duty cabling to artfully camouflaged aerials. From a distance they are only barely discernable from the sandstone tower walls. Carefully he opens the three yellow boxes to reveal their inner secrets (see figure 4.2 on the next page).
>
> From his coat pocket Marc grabs an electronic scheme showing the functions of the various cables and buttons. The cover reads Debugging checklist node Cetim. Marc explains: "I got this manual from Ed. He knows a lot about computer networks, and wrote down this debugging manual so people like me who are not really experts, can still do checks on their own."
>
> After reading the description, Marc presses some buttons, watches some lights switching on and of again and compares their status with his scheme. After a few minutes the devices seem to have been properly restarted. Look, the LED's are blinking again; I presume that means the node is connected again. A smiling Marc: "Mission

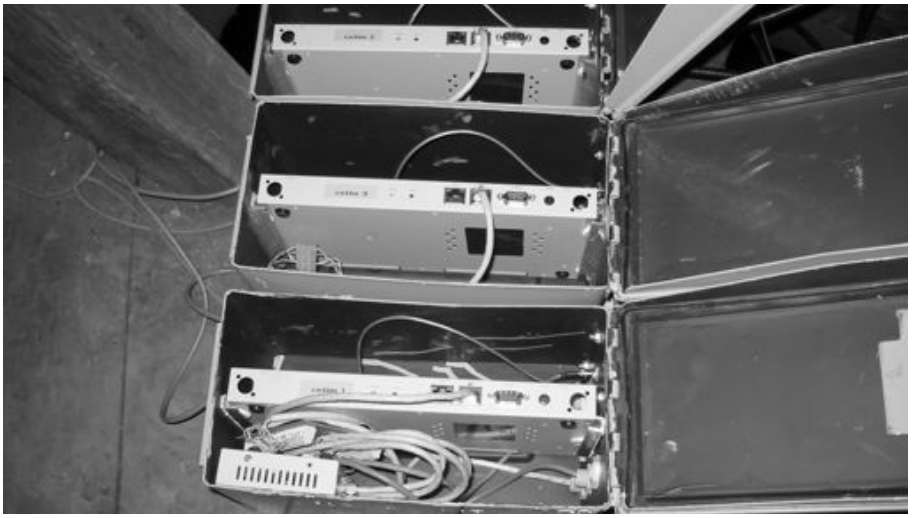


Figure 4.2: Opening up the yellow boxes of Node Cetim for inspection by node adoption volunteer Marc

> accomplished". It's time to go home. We descend the stairway again, switch of the church lights, carefully lock the church door behind us and return the key to the parish clerk.

This description vividly illustrates the myth of the autarkic artefact. A functioning node Cetim is anything but an isolated artefact, but is fully embedded in a complex socio-material infrastructure of support. Although Marc as NAV is central in this support network, also other actants like e.g. the parish clerk, the church key, the torchlight and the debugging checklist are indispensable for realizing a reliable, functioning network node Cetim.

The invention of the 'node adoption volunteer' is based on the home user's specific interest in the correct functioning of 'their' local node. Their involvement into enacting care work is based on their local attachment to individual pieces of the infrastructure; mirroring maintenance and repair as described in de Laet and Mol (2000). As such inventing the 'node adoption volunteer' can be seen as a pivotal element in the community innovation process. This also fits in with defining technology as a "configuration that works" (Rip and Kemp, 1998), although in this case home users are mobilized as well to 'making things work'. However, this emphasis on understanding the role of home users in innovation, does not answer the question what some home users of Wireless Leiden drives to transform themselves into Node Adoption Volunteers. The next section will address an analysis of the underlying mechanisms.

4.3.2 The warm user

Informal support helping people becoming 'hooked up' to network technologies is not something exclusively restricted to community innovations. In her

research on the domestication of the Internet, Bakardjieva (2005) noticed a similar phenomenon. The fact that Bakardjieva explicitly focused on domestication of Internet access allows for a comparison of her empirical material with the Wireless Leiden study. Bakardjieva (2005, 98) noticed that the "domestication [of the Internet] had been intensively assisted by a close friend". Out of her empirical data Bakardjieva developed the concept of the warm expert which she defined as:

> "The warm expert is an Internet / computer technology expert in the professional sense or simply in a relative sense compared with the less knowledgeable other. The two characteristic features of the warm expert are that he or she possesses knowledge and skills gained in the system world of technology and can operate in this world but, at the same, is immediately accessible in the user's lifeworld as a fellow-man / woman. The warm expert mediates between the technological universal and the concrete situation, needs and background of the novice user with whom he is in a close personal relationship." (Bakardjieva, 2005, 99)

The 'economy' of the warm expert helping out a close-by person is not a financial one such as the relation between repairmen and customer, but gift-based. In return for helping out, the warm expert is offered for instance "lunch and, as one can imagine, the enjoyment of spending time with a friend." (Bakardjieva 2005, 101). In Wireless Leiden we see the same mechanism at work, although the gifting is related to the Wireless Leiden community. In the previous stories of Wireless Leiden users we have seen a 'gift economy' in action, in which reciprocity towards the community ('tit-for-tat') is keeping-it-all-working. When an expert helps a user to get connected, the user then is asked to help the expert, for example by translating 'debugging check lists', by giving a presentation in non-technical language or by taking over relatively easy maintenance tasks. In this way users are actively involved with stabilizing connections by maintaining technology and supporting the community. A difference emerges between getting connected to the Internet via a commercial ISP or via a community innovation such as Wireless Leiden. In her introduction Bakardjieva writes that:

> "Users are hard to perceive as a social group that shares a common technological frame because of their dispersed state of existence, as well as their diverse cognitive and material resources, interests and ideologies. Users inhabit numerous invisible everyday settings. They have no established forums or channels for interaction either with each other or with the designers of the technologies they employ. In contrast, researchers, engineers, managers and government representatives form distinct professional networks. They share cognitive frames of reference acquired in the course of their training and subsequent participation in a community of practice." (Bakardjieva, 2005, 13)

In community innovation, however, users are not dispersed due to the availability of forums and communication channels in the form of local meetings,

mailing lists and interactive wiki's. These channels not only enable communication with other users, but enable direct interaction with the designers of the system as well. For warm experts to be able to function in the case of community innovation in which people are often no friends (yet) or relatives, there is an infrastructure needed through which people can ask for help.

This 'infrastructure of support' enables both the correct configuring of users as well as devices enabling stable interactions with each other. Within a community innovation the gift economy is a central principle on which maintenance and support work is organized.[6] Examples of reciprocal gifting by users in return for help are writing documentation, answering other users' e-mails, giving presentations, etc. The economy that enables Wireless Leiden to function is not a financial one, but one based on gifting involving 'warm' relations. Where in the commercial innovation users pay money to a company to compensate for the salary of repairmen, in the case of community innovation, users 'pay' the community of which the warm expert is a member, by donating resources back to it in the form of time, energy or concrete products such as manuals, documents, bug reports, or answers to questions.

In the situation of a commercial Internet access subscription technologies are expected to be stable black boxes, with companies expected to fix problems. However, in relation to community innovations, users are more forgiving and prepared to participate in helping when fluid technology falters or fails. In this sense not only warm experts with their intimate knowledge of technology can help users; in addition warm users with their intimate knowledge of how they experience new technologies work can help both experts and devices supporting the community innovation. If linkages between elements and the network get disconnected, warm users can help to repair them. Warm users, like the Node Adoption Volunteers, thus are an essential part of the 'infrastructure of support' that allows community innovations to stabilize.

In my analysis of the maintenance work performed by warm users, the focus is not so much on the individual user, but on the community innovation as a whole, including all its constituting humans as well as non-humans. This implies a broader scope of the dynamics of warm relations in the use of technology. Where Bakardjieva (2005, 102) writes that "[t]he learning experiences of new domestic users of the Internet [...] exhibit a profoundly social character" I argue that the learning experience of warm users in Wireless Leiden is not only socially through local meetings and personal visits, but also technically organised through wiki's, mailing lists, homebrew 'debugging lists'. Second, Bakardjieva emphasizes the dynamics in which users learn what technology can do for them: "Friends and relatives, and to some degree online helpers, had taught my respondents not only how to navigate the interface but also what they themselves had discovered the Internet could do for them as a communication

[6] Two sociological classics on gift culture are Malinowski (1922) and Mauss (1925). A recent work on gift culture in general is Godelier (1997), or more specifically in relation to communities Eckstein (2001). Examples of recent literature on digital gift cultures are Bergquist and Ljungberg (2001), Zeitlyn (2003), Ripeanu et al. (2006), and de Lange (2008). Finally, Harper (1987) gives a very detailed account of a gift culture 'in action' in the specific context of technological care work in a local rural community in the United States.

medium." Bakardjieva (2005, 102). In this analysis I showed that Wireless Leiden users not only have learned what Wireles Leiden can do for them, but additionally learned what they can do for Wireless Leiden. Where support of users is organized by warm experts helping people to get connected, the equivalent is maintenance of the technology organized by warm users who care for devices and their proper functioning. The warm relations involved in the activity of caring thus not only apply to other humans but also to non-humans.

4.4 Caring about technologies

Although home users and the warm relations they develop in caring for technology form a crucial part of the maintenance arrangement of the Wireless Leiden community innovation, they are certainly not the only ones. In this section I zoom in on other, often more complicated and specialized types of care work involved in maintenance and repair work related to the scaling up of the Wireless Leiden network. This work required specific knowledge and competencies often not available with the average Wireless Leiden home users. Consequently, this type of care work was delegated to a core group of technically skilled volunteers who primarily perform work to construct and expand the wireless infrastructure.

4.4.1 The challenges of scaling up

Before zooming in on the micro-interactions between different actors entangled in actual maintenance practices, I will briefly sketch some developments that proved to be especially challenging during the scaling up of the Wireless Leiden network. Firstly, the number of nodes increased within the first years from a few to around seventy. Because nodes often consists of several node machines and often have more than one wireless connection to other nodes, complexity increases non-linearly with the number of nodes. After the network consisted of over 40 nodes, the then used open source implementation of the OSPF routing protocol was no longer able to handle the task. Getting routing repaired, was a large challenge of technical nature that only was solved after one Wireless Leiden volunteer succeeded to write new routing software (LVrouteD) from scratch which has proven to function reliably.

With a scaling up, not only new routing software proved essentially in realizing reliable connections, but too standardization work proved crucial to handle the rising complexity of preventing the network to fall apart. It became increasingly important to automate and standardize the configuration of the node machines. For this purpose volunteers constructed the NodeFactory and a configuration database Genesis. The combination of the two enabled the automatic generation of individual operating software image, based on the FreeBSD operating system, which contained all the necessary software correctly preconfigured for providing all the standard functionality of a network node: the routing software, a DHCP-server, a DNS-server and a SSH-server

enabling remote login for system administration maintenance tasks such as software updates and configuration fixes. This specific configuration even enabled updating the node software over the Wireless Leiden network itself. However, the new technology developed to maintain nodes, too required itself maintenance and updating. Keeping the NodeFactory itself up to date with new versions of the FreeBSD operating system turned into a challenge of itself, after the Wireless Leiden volunteer in charge of this task became involved in a huge flaming-war around the topic of commercial use of Wireless Leiden knowledge (see chapter 5). In the end it would take several years before in the summer of 2009 a new volunteer would step up to take over the maintenance and further development of the NodeFactory. This example illuminates the importance of stable connections between humans as well as non-humans in realizing a reliable community innovation. The management of care work too involves keeping crucial human actors aligned to the network.

The increasing number of nodes was not only a challenge to the maintenance of the node software, but proved to be a challenge for hardware maintenance as well. Initially, due to cost concerns most node machines would be constructed from recycled discarded personal computers that were donated to Wireless Leiden. Although the machines were cheap in acquiring costs (usually limited to the cost of transportation for getting the PCs from the donors to the Wireless Leiden office), but turned out to be costly in terms of time and energy. For example, all moving parts such as the CPU fan, the power supply fan and the hard disks, demonstrated themselves over time to be especially failure-prone. For example the power supplies were never designed to be on for years in a row.

Frequent failures of recycled PCs would then mean that a volunteer would have to perform site visits often, in order to replace broken parts. Additionally, there were the added costs of the diversity of the hardware. For example, the node machines were used without monitor and keyboard attached to the PC, something a human user would not like to do. Because this type of use, namely reconfiguring a desktop PC to function as 'embedded' system, meant that the BIOS had to be reconfigured explicitly to not provide boot errors after a reboot. However, there is no standard procedure for accomplishing this task. The details differ between every PC brand, and sometimes also between different versions. This means that the diagnosis of hardware errors on recycled PCs requires a lot of knowledge and debugging competencies. Even so much, that it would be unfeasible to provide precise guidelines for untrained non-expert volunteers. So for all these reasons, over time it was decided that new nodes would be built with standardized hardware parts, of which most of the specifics, including the good, the bad and the ugly, would be known in advance. Configurations that had proven themselves would then be used in as many as possible nodes.[7] Additionally, if funds would become available, older node machines would be replaced by standardized embedded hardware as well.

[7] In most cases this configuration existed of embedded Soekris main-boards with Senao long-range 802.11b Wi-Fi cards 'flashed' with a specific firmware, known to work well for outdoor wireless configurations.

Sometimes volunteers creatively included quite different technology into the network to which they delegated a specific maintenance task. An illuminating example is the use of an electronic time clock for preventing node machines to simply "freeze" — without specific reasons — over time as regularly happened. Since the PC operating system itself freezes, no remote intervention is possible. The restarting of the node machine would require a time consuming manual 'hard' reset. By linking unreliable node machines to an electronic time clock inserted between the power supply and power outlet, the hard reset was delegated to that artefact. The time clock would remove power for a few minutes every 24 hours, implying an automatic restart of the node once a day, preventing it from unexpected software freeze.

In this section I have given an impression of the types of maintenance challenges the growth of Wireless Leiden infrastructure brought to the fore, and what care work volunteers did to cope with these challenges. In the next section I will zoom into the more detail into the various maintenance activities by following the career of a particular WiFi node, using the "follow the actor" methodology as proposed by Latour (1987).

4.4.2 Node Unigor: Following a mutable mobile

To find out how nodes are kept functioning in a stable and reliable way, I followed a particular Wi-Fi node in order to gain a detailed insight into the underlying dynamics of maintenance arrangements. In this case the actor I followed carries the name Node Unigor, a node conceived of by the Wireless Leiden initiators somewhere in the beginning of 2003, and then designed, build, test and put to work during the summer of 2003. The dedicated Node Unigor information page in the Wireless Leiden wiki dates the 'first packet' sent to 15 May 2003, 15.00 hour. The physical equipment of the node is located at the top floor of the Leiden University Faculty of Chemistry, a high block of flats.

Figure 4.3 on the facing page shows the node installed in a small, unused room hidden away at the top floor of the University building. Cables running outside connect the node to the Wi-Fi antennas outside.

In 2004 some changes were made to the node, which included replacing the recycled PC for another one. Overall, node Unigor operated as expected and sunk into the background. However, during the summer of 2008 the node made itself being noticed by volunteers due to dropping connections. After years of reliable operation, its operations ceased to be stable. Suspecting problems with either the power supply or cooling fans, both commons sources for problems in recycled PCs, the volunteers decided to replace the recycled PC hardware again.

> Leiden, 20080729, Thursday. Today Rene is going to replace the recycled PC of Node Unigor with another one, and I am going to accompany him. For a while the whole project was stalled, because there was no-one with a car to transport the replacement PC from the Wireless Leiden office in the centre of Leiden to the Gorlaeus Laboratory. Usually Rene's favourite mode of transport is his moped, but he is worried that the replacement PC will not survive a bumpy

Figure 4.3: Initial incarnation of a node

drive on the back of his moped's carrier. Due to the vibrations parts can get loose, and then it will be difficult to diagnose the exact problem when the PC no longer functions correctly. In order to be able to observe the repair work for Node Unigor, I volunteer to come to Leiden with my own car, so together we can safely transport the replacement PC within Leiden.

After I have picked up Rene at his home in Oegstgeest, together we drive to the Wireless Leiden office, currently located at the Langebrug 56a. The building is a former fire station. Due to good contacts between Wireless Leiden board members and the Leiden municipality, they can use the building for free until a new purpose has been found. Rene tells me he is concerned about how long this this agreement will last. In one of the offices upstairs we find the replacement PC. A written note next to it lists what work was done by whom at what date and the current status of the machine (see figure 4.4 on the next page).

The note reads:

"Replacement of Node Unigor. PC appears to work. Hard disk replaced with Compact Flash, is installed: Flash not yet configured, got no files from genesis: Peter (20-7-08)."

"Card is programmed. Update series did not go off flawless. Better take card from old machine!!! Machine does boot with card. I put in some wireless cards in the slots for a little while and they are blinking. Ad 21-7-08"

I ask Rene if he is sure the machine will work properly. His answer is that we are going to swap the machines anyway. If there

Figure 4.4: Picking up replacement parts at the Wireless Leiden office

might be some problems afterwards, other more knowledgeable volunteers can always remotely login to fix potential software or configuration problems. I pick up the PC, put it in the trunk of the car and together we drive to the Gorlaeus Laboratory. Taking a sharp turn, I suddenly hear the PC slide from one side of the trunk to the other, loudly bumping when it hits something.

Arriving at the building we have to announce ourselves at the reception. The person at the desk displays a suspicious look at the sight of the clearly outdated and dingy looking PC which we try to import into the building. Our explanation that we come to repair a node of the Wireless Leiden network installed on the rooftop of the building seems to evoke only more questions. Due to safety restrictions we have to register, wear a visitor's badge in a clearly visible place, and wait to be picked up by our local contact person, in this case Hugo. The moment Hugo arrives at the scene the tension with the security personnel at the reception desk is resolved. Rene and I introduce ourselves to Hugo. Hugo tells he works as head of the local IT help desk group. He also tells us that he is one of the people who build and installed Node Unigor. However, due to time constraints as a result of a combination of work and study, Hugo is no longer actively involved as volunteer. I ask Hugo and Rene if they know each other, but both cannot seem to remember having met each other in person. Meanwhile, we walk through a maze of elevators, hidden stairways and "no entrance" signs, in order to arrive at the location where the node is installed. Then Hugo takes a look at his watch and tells us he will be back in half a hour to

Figure 4.5: Deconstructing a node for replacement

check up with us how things are evolving.

Time for the replacement procedure. Rene climbs up an empty desk in order to reach the node that is mounted close to the ceiling (see figure 4.5).

The node itself looks like quite a mess containing a crisscross of cabling. It takes Rene some time and effort to disconnect all the different wiring: antenna, Ethernet and power cables. The Wi-Fi cards also have to be unmounted because they also move over to the other PC.

Next, we put both the old and new PC on the desk and remove their covers to be able to work on their insides. To be sure, Rene uses the compact flash card of the old PC in the new one.

So far, so simple. Time to put the new recycled PC back on the shelf and reconnect all the cables. Then a problem arises: one of the Wi-Fi cards refuses to slide back into the slot at the backside of the new PC. After some attempts Rene gives up. He fears that putting on too much force will damage the card or its connector. I climb up on the desk and try as well, unfortunately to no avail. Hugo comes in again and asks how it goes. After the update on the stubborn Wi-Fi card, Hugo climbs up to give it a try as well (see figure 4.6 on the next page).

Still no success. Time to take disconnect the PC once again, opening up the cover and look inside to diagnose the problem. It is Hugo who discovers the culprit: “Ha, look here, this pci card slot is slightly bent, preventing the Wi-Fi card to line up correctly with the

Figure 4.6: Struggling with a stub-born Wi-Fi card

connector inside". After applying some force with a screwdriver the card finally slides in.

Time to test the node. First all the cables have to be reattached once again, and then the PC can be powered on. A new problem surfaces: one of lights of the Wi-Fi cards does not come on. Rene explains that this usually means that it is not recognizing by the FreeBSD operating system. This also means that now one of the wireless links no longer functions anymore. Some doubts arise if the cards have been installed in the exact same order in which they were located in the previous node PC. According to Hugo, this should cause problems. He continues with a short lecture on BIOS initialization routines, the PCI bus of the Intel 286 PC architecture, 'South' bridge chipsets and specific implementations of PC motherboards, but somewhere in between the jargon I lose track of his all this relates to the current problem or getting it solved. Nonetheless from his expose, I deduct that Hugo is an expert on computer technology based on his theoretical understanding combined with his hands-on experience. However, the frequent glances at his watch, seem to indicate that Hugo is in a hurry, and gives me the feeling he rather would like us to finish the job.

In the meanwhile Rene decides to consult the original configuration file of the node as it is stored in 'genesis', the on line node configuration database. Using his mobile phone to connect to the Internet he logs into genesis after typing in his user name and password. However, all to no avail. Subtly pressured by Hugo to finish the work, Rene decides to leave the situation as it is. He explains

> that other more knowledgeable volunteers can always log in remotely to try to get the stubborn Wi-Fi card correctly configured again.

After my visit to Node Unigor, Rene sends a short update to the volunteer mailing list. Another volunteer, Ad, replies by promising to look into the matters to try to solve the problems. When he is not able to fix the problem remotely by logging in, he announces he is going to visit the node on-site to find out the cause of the culprit Wi-Fi card. This allows me to accompany another volunteer on his visit to re-repair this troublesome node and turn it into a nicely disciplined machine.

> Leiden, 20080801, Friday morning. Standing with a rented bike in my hand, I wait at the backside of the Leiden Centraal railway station. I am waiting on the arrival of Ad, the volunteer who announced on the Wireless Leiden volunteer list that he will visit Node Unigor today to try to fix the non-responsive Wi-Fi card. For about fifteen minutes we bike together to the University Leiden building where the node is located. Then the whole check-in ceremony of a few days ago repeats itself again. However, this time our local contact person Hugo seems much more relaxed and less in a hurry. When we arrive at the node, Ad opens up his tool bag and unpacks some network testing tools, an Ethernet cable, a serial cable and his laptop he took with him from work. The first thing Ad does is connecting up his laptop with the node machine to engage in running a series of diagnostic software programs (see figure 4.7 on the following page).
>
> "Strange", says Ad while he looks puzzled. "It just doesn't make sense." Silently, he removes the cover from the node machine and starts to check all the internal connections of the Wi-Fi cards. As a final resort he then switches the three Wi-Fi cards from their internal position. Ad then reruns the diagnostic tests on his laptop again. "Ha", he utters clearly pleased, and then explains what he thinks was the cause. "Must have been some dust in one of the contacts. Happens more often. Would also explain the fuzziness of the problem." Ad packs his stuff together, and phones Hugo on his mobile for escorting us out of the building.

Due to all the problems with the node, a discussion starts among board members and on the volunteer mailing list. After a while, it is decided that the fragile node PC is to be replaced by a more robust embedded node machine. Volunteer Koos will start building a more reliable embedded node machine as replacement. Over time he has specialized in this type of work. So adding even more to the distributed nature of the maintenance work, here we see the introduction of yet another volunteer (Koos), working on the maintenance of Node Unigor from yet another place (Jacobswoude, a rural village about fifteen kilometres apart from Leiden). I have visited Koos at home where proudly showed his own node

Figure 4.7: Re-examination and re-repair

Figure 4.8: Volunteer displaying standard node casing.

machine production facility, specialized in the manufacturing of embedded node machines and their enclosures (see figure 4.8).

On 6 January 2009, the transplantation of the embedded machine, as new digital heart of Node Unigor takes place. After the operation has been successfully performed, pictures are taken for inclusion in the Wireless Leiden online repository, both for those interested in the results, as well as for future reference (figure 4.9 on the following page).

It also enables me as a researcher, located hundreds of kilometres apart from the physical location while watching the digital photographs, to track the current incarnation of the node that has served as an example for the pattern of circulation of boxes, parts and people through space and time in order to keep the data-packets flowing despite the fluidity of the underlying network node infrastructure. What strikes is the contrast between the stability of the function of the node as black box and the state of flux of the contents of this particular black box. In this case stability in the sense of "keeping the function the same" over time is achieved by a constant cycle of repair and redesign.

4.4.3 The virtuoso volunteer

As shortly described in the introduction of this chapter, most of the technically skilled volunteers are only interested in experimenting with a new technology and not in reconnecting a wireless node for the hundredth time. As a solution routine care work, not depending on technical competence was delegated to home users. This means that the question remains on how Wireless Leiden as community innovation deals with all care work involved in maintenance and repair that requires specific competences, knowledge and skills. How are

Figure 4.9: Node Unigor as embedded machine.

complicated problems solved, and how is the functioning of the network as a whole maintained? In this section I zoom in on the care work enacted by Wireless Leiden volunteers. What do their care work practices involve, and how can we understand the fact that these active participants do, as their name, volunteers, already implies all this work for free? One thing is clear: in contrast to the Wireless Leiden home users, the volunteers are not primarily interested in free Internet access, as most of them already are connected to the Internet by commercial broadband connections. So how can we understand the interest of volunteers in performing care work for the community innovation?

In short, this section argues that we can understand the involvement of Wireless Leiden volunteers in the more complicated technical maintenance and repair activities as identity projects. In and through the hands-on involvement in the Wireless Leiden actor-network, the volunteers shape their selves as subject-networks, by "patching" their identies with all kinds of specific technical competences. As a result of this interaction between technical volunteers and wireless community infrastructure, the technical identities of both Wireless Leiden and its volunteer-participants are co-constructed and maintained. Wireless Leiden and its technical maintenance challenges, offers an infrastructure for the extension of subject-networks, or stated differently, it offers a stage for performing identity work. By reframing the volunteers' care work as identity work (Faulkner, 2000; Oldenziel, 1999), we can better understand what it is that makes precisely this kind of practice attractive for those enlisted as volunteers.

4.4.4 Caring as intellectual challenge

Some maintenance problems generate complicated technical puzzles. Volunteers are thrived by the intellectual challenge to find a creative solution to tough problems, especially when repair work leads to redesign. In this way in order to fix something, an actor has to think up, design and implement a new solution. Succeeding then offers an intellectual reward, and the recognition of competence by peers; eventually leading to an increase in reputation, sometimes even exceeding the boundaries of the innovation community.

Wireless Leiden depends on volunteers fixing problems by redesigning them, I highlight one story in order to get a better understanding of how maintenance by redesign is enacted in practice. The technical problem in this story is the breakdown of the software responsible for the routing of data packages over the wireless network. The technical challenge was finding a structural solution. One of the first major challenges that emerged while scaling up Wireless Leiden from a few nodes to several dozens, was the breakage of the routing software. One of the first serious problems concerning the stability of the operation of the network Wireless Leiden encountered was the erratic behavior of the routing software. Initially Wireless Leiden had chosen to use the OSBF protocol for this task, implemented as open source software in a program called Quagga (a fork of GNU Zebra). However, after reaching about a hundred connections between nodes, this software became unstable. The network would split into two parts that would no longer communicate with each other. The Wireless Leiden wiki offers the following explanation of the problem:

> "In the Wireless Leiden network the dynamic routing through OSPF appeared no longer to function correctly. There was a problem in the Quagga OSFP implementation. When a connection fell away for a longer period of time and this connection would come up again on radio and IP level, OSPF could no longer initiatialize this link. One part of the network could no longer communicate with the rest of the network."

The first solution for the problem consisted of a complicated procedure of restarting all the nodes from the periphery towards in the centre of the network, the software would correctly function for a while, until the next breakage would occur. The problem seemed to be caused by the fact that no one had previously used the software on the scale and sophistication that Wireless Leiden had achieved by now. The second attempt at fixing the problem was choosing for static routing. Volunteer Lodewijk Vöge wrote together a collection of scripts in order to configure static routing. However despite the software tools, managing all the connections still implied a lot of manual work, and the result was a less robust, more error-prone network (because nodes would fail all the time and the network should be able to automatically deal with this given unstable nature). After a close inspection of the source code of the Quagga OSPF protocol implementation, Vöge decided – based on his experience with the static routing scripts - to write his own dynamic routing implementation loosely based on

OSPF.[8] This innovative, new software, that would dynamically route all the data packages on the network, turned out to be a great success according to the following press release:

> Wireless Leiden improves Wireless Network reliability (December 8th, 2004)
>
> Wireless Leiden The Netherlands has successfully developed new software for the reliable operation of large wireless networks. These networks should adjust rapidly and automatically to changes in the network, such as new or disappearing interlinks. Many research organizations are developing this so called 'dynamic routing' that could enhance the reliability and scalability of these networks enormously.
>
> "Initially we tried the software that is being used on the Internet for variable but fixed networks" says Lodewijk Vöge, Wireless Leiden project leader. "But a wireless network like ours has a different topology with a lot of interconnections. Above say a hundred interlinks the situation became unstable and the network appeared to break up into two separate parts. I then decided to start more or less from scratch."
>
> The computers at the network nodes assess the availability of their interlinks and communicate this information to the other nodes. That is the basic principle of any dynamic routing system. The difference is in the type of information that is being exchanged and the way the nodes reach consensus on the optimum routing paths. "Our version is fast, simple and it appears to work", says Vöge. Like all the technology that is being developed by Wireless Leiden the software is available under an Open Source license and can be downloaded from the Internet.

For Vöge solving this complicated technological puzzle formed a great intellectual challenge. Wireless Leiden functioned for him as stage that creates visibility for his technical competence.

4.4.5 Wireless Leiden as stage

In this section I will look more closely how Wireless Leiden functions as a platform that creates increased visibility for the technical competences of its active volunteer participants. First of all, the aura of virtuosity of Wireless Leiden as collective innovation project reflects on its individual volunteer participants. This allows them individually to surf on the waves of fame of the collective as a whole. Some isolated individuals tinkering with Wi-Fi devices easily get lost in the background noise of our present day technological culture. Sure, nowadays anyone interacts with advanced technologies, including configuring Wi-Fi connections, as part of their everyday life, so what highlights the activities

[8] For this task, however Vöge wrote his software in Occaml, a not very widely used programming language.

of a few hobbyists to warrant attention by broader audiences? In the case of Wireless Leiden, it is the 'brand name' of the collective. Wireless Leiden has grown to become synonymous (at least in some circles) with the designations 'innovative' and 'technologically advanced', formalized in receiving the Vosko award targeted to innovative pioneers in the domain of information technologies. This enables its participants automatically to be presumed technically competent as well. Wireless Leiden is a complicated infrastructure, so those running it, surely must be skillful technologists.

Secondly, Wireless Leiden offers numerous communication channels for increased visibility. These communication channels are part of the community innovation infrastructure, consisting of mailing lists, a website, a wiki, and a repository. Interestingly, the Wireless Leiden website contains a special volunteer members section, listing all the officially enregistered volunteers, including a picture, their full name, and a short description of the nature of their involvement and area of expertise. By answering other people questions on the Wireless Leiden mailinglists, helping them finding solutions, volunteers display their technical competences. In this sense, they build a reputation for being competent and knowledgeable.

A special form of becoming visible as individual is to sign special information with the name of its original author. Where e-mails automatically contain the name of its author, this is not true for other types of digital documents. This signing is common practice within Wireless Leiden on the wiki, and also for information stored in the repository. Especially software code is explicitly signed with the name of its authors. For example the software written by Lodewijk Vöge explicitly mentions him in the source code comments as the author, and provides his contact details. The fact that his code is also heavily commented to increase readability of the code for possible interested actors, also makes explicit that the software code is not only meant to set computer hardware in motion, but is also targeted towards a human audience. During an interview, Vöge also mentioned a big multinational actually contacted him, after having studied his software code, to invite him to apply for a job as a technical engineer.

Thirdly, through relationships with the members of the press, various news media function as additional channels for visibility. Most of the actual news reports on Wireless Leiden are also stored in either a digital scan, a sound or video file, or hyperlink on the "news" section of the Wireless Leiden website.

A fourth podium for visibility is offered by open meetings, presentations and weekly consultation hours. Most of these are organised within the context of Wireless Leiden, however some take place on events such as conferences, symposia or hacking events. These performances also offer possibilities for the presenters to display their technical knowledge and expertise. Often the digital representations in the form of 'pdf' or 'powerpoint' files are also stored in a publicly accessible and search engine indexable part of the repository.

Actors themselves are explicitly aware of the fact that Wireless Leiden serves as platform for increased visibility of their technological virtuosity. One actor stated the following:

> "Although I am no longer an active volunteer anymore, I do not

> mind being listed as volunteer on the Wireless Leiden website. I even made sure that some of my presentations are stored in SVN. I like the fact that when people Google me, the search results indicate that I am involved within Wireless Leiden. This even helped my to acquire a paid job."

Other ex-volunteers still refer to their previous involvement with Wireless Leiden as an indicator of their technical competences in the area of wireless networking. For example, Jasper Koolhaas, a previous president of the Wireless Leiden board, explicitly mentions his involvement in his biography section on the website of his current company Geluidsnet, specialized in distributed sensor networkings, measuring for example actual airplane noise levels as heard on the ground near airports, providing inhabitants with quantified evidence of noise nuisance opposed to the mathematical models that airports themselves deploy to predict noise levels. Another common practice, is mentioning the involvement within Wireless Leiden on people's curriculum vitaes, either on their personal webpages, or on professional networking sites such as LinkedIn.

To sum up, in this section I have conceptualized a community innovation as a locus offering a 'stage' for performing technical competencies, and visibility to certain audiences in order to explain why volunteers are involved in care work. Although self-interest is involved, the WiFi community innovation functions as a collective interest-translation device based on the principle of reciprocity. The volunteers breathe life into the collective, while simultaneously the collective grants the volunteers there identity as technology virtuosi. In this sense volunteers use the community innovation for their own individualistic goals as much as the home users who are primarily interested in free, zero-cost Internet access. However, use in this sense is two-way, it is mutually constitutive: the collective also "uses" both the home users as well as the volunteers as a resource of labour for care work. It is the collective that enables the translation of all the different interests in ways that make both individuals as well as the collective stronger. This reciprocal relationship is central in my understanding of how community innovation can become robust and stable.

4.5 Conclusions

Opening the black box of maintenance revealed its relevance and importance for realizing stable and robust community innovations. My analysis indeed revealed that care work is abundantly present in daily practices and routines of Wireless Leiden preventing the network from falling apart. This care work is inextricably intertwined with and distributed over the hybrid collective Wireless Leiden because of the delegation of various tasks and responsibilities over the three groups of actors: home users, volunteers and machines. Crucial to the understanding of community innovations and the pivotal role of the multiple and heterogeneous types of care work, is that this work is rooted in a gift-based economy where reciprocity is a fundamental principle.

I have argued that we cannot understand the stabilization of fluid technologies without explicit attention to the roles of home users. I have given voice to this — often rendered invisible — role labelling these actors as warm users. In doing so, I aimed to enrich the image of users as 'simple customers' (Latour, 1987, 137) into one of 'active participants'. Warm users care for their technology they use and perform crucial maintenance tasks. Examples of tasks delegated to warm users are error reporting, routine maintenance, parts replacement, or sharing user experiences.

Machines themselves too are indispensable loci for performing care work. Various types of care work are delegated to technology: (1) remote access facilitating acting of volunteers at a distance, (2) self-reporting of their "health status" by artefacts themselves enabling decentralized monitoring by volunteers, (3) anticipating instabilities by designing-in dealing with failures, (4) reducing complexity by standardisation and black-boxing. All these elements function as 'stabilizers', aiming at higher levels of reliability, and robustness.

The delegation of tasks to home users and machines is often the outcome of redesign work performed by the volunteers aiming to decrease the care work load that can grow to unmanageable size with the growth of the network infrastructure. Technically skilled volunteers are indeed indispensable for maintaining community innovations stable and robust. For them, Wireless Leiden functions as a stage where they have the space and facilities to perform their creative, virtuous technical skills. They are central in not only executing various maintenance tasks like remote diagnosis, debugging, repair by redesign, and remote administration, but simultaneously they design themselves these tasks. This co-creation is a core outcome of the understanding of maintenance as innovation itself, which is especially true for community innovation.

To sum up, I can conclude that care work in community innovation is indeed inextricably intertwined with the innovative character of the Wireless Leiden collective itself, emphasizing Suchman's idea that maintenance cannot be separated from the innovation itself (Suchman, 2002, 142). The myth of autarkic artefact is debunked, indeed.

Chapter 5

Coordination work

> "[Wi-Fi] has led to the fascinating phenomenon of the cooperative wireless network. [...] The single best piece of advice I can give you on your journey to the ultimate network is to fight the urge to blindly go it alone. [...] This kind of massively parallel, cooperative arrangement is what makes a high speed wireless wide area network possible. However, I can only give you the technical details; the social details are left as an exercise to the reader." Flickenger (2002, 50)

> "Building a wireless network is relatively easy, but making it work is much more of a business problem than a technical problem." Flickenger (2006, 229)

5.1 Introduction

5.1.1 Discovering conflicts

After reading the empirical chapters of this thesis until now, an image might have appeared of Wireless Leiden as a harmonious bunch of 'happy people' getting along well all the time. However, such an image would be complete fiction, only describing an Utopian version of community innovation. In practice, irritations, disagreements, disputes, discussions, flame-wars and controversies over the different values of community innovation is part of the game as well. I discovered these frictions only in the final phase of my fieldwork in July 2008 during an interview with Hugo Meiland, a former Wireless Leiden volunteer. As he was no longer active within Wireless Leiden since 2004, I had not interviewed him before. Only when reconstructing the history of a specific node (Unigor, see Chapter Care work), I discovered that Hugo had been involved in the initiation of Wireless Leiden. When closing off interviews I ask referents if something was not yet discussed that in their view should have been. Usually interviewees then respond that all important issues have been addressed. However, when I asked

Hugo this question, he mentioned that he was surprised I had not brought up "the whole issue about commercial activities". This was an important debate spanning many messages on different mailing lists. He added that no clear decisions had been taken on how to deal with commercial activities within Wireless Leiden. Not clearing up this ambiguity had become a serious hindrance to further development, he concluded.[1]

From the start of my research project, I was aware of the complexity of doing-things-together and the massive amount of labor keeping it working, creating heterogeneous links, and connecting chains composed of both things and people. Keeping everything connected and links functional despite forces of resistance. Aligning the identities of individuals' subject-networks with the collective identity of an actor-network organized around tropes of technical competence. Extending a community innovation network into many different homes. However, actively involved in following the actors to understand their cooperative collective, I initially missed conflicts and tensions between actors. Concentrating on understanding *how* actors were involved in Wireless Leiden, I missed the sometimes irreconcilable differences in the reasons *why* these actors had become involved in it. Although for all active participants their association with Wireless Leiden meant a lot, I would discover large differences in how this attachment actually mattered and how it was valued.

Therefore, in this chapter I explore why in community-based innovation actors do what they do. In psychological terms one could ask questions about

[1] Interestingly enough, Hugo, making this remark, himself was no longer actively involved in Wireless Leiden. All previous interviewees had been actors still actively involved in Wireless Leiden (not counting, potential, home users). These participants had brought up neither any issue of friction, nor the issue about commercial activities. Perhaps another reason for initially glancing over this particular debates, apart from the fact none of the interviewees mentioned them, is the fact that it took place before I started studying this case. Luckily many arguments were communicated via emails archived on the Wireless Leiden website (although protected with a password), which enabled to follow its traces even years later. The methodological point here, is first stressing the importance of triangulation. For example comparing statements from interviews, with messages on e-mail lists. In this case however, the difficulty was that the theme of frictions about commercial activities was something all active Wireless Leiden actors were silent about. Only later, through observations of volunteer meetings and free consultancy hours, I discovered the implicit rule amongst Wireless Leiden members, that "you don't wash one's dirty linen in public". For example, you do not communicate internal frictions or technical problems on the user list. In a similar fashion, as a Wireless Leiden volunteer you do not sketch an image of an internally divided community to the outside world. Of course, in sociology such findings are not new. Sociologist Irving Goffman convincingly illustrated how such 'team repair work' is kept hidden from the public by confining it to 'backstage' areas (Goffman, 1959). As Hugo was no Wireless Leiden member anymore, he no longer need to comply to such implicit rules. Therefore, as a respondent he was in the position in which he could freely talk about such backstage team repair work. This brings us to the question on why participants kept silent on issues of frictions during interviews, while not holding back in emails sent to mailing lists. At first sight, this might seem counter-intuitively. However, it is quite logical once one realizes that except for the user list, all other mailing lists are not publicly accessible, but only to its subscribers. In the case of Wireless Leiden, only those who signed an official document, namely the 'volunteer contract', can subscribe. This means that there are clear boundaries between the areas for discussion provided by Wireless Leiden mailing lists and areas freely accessible to a wider audience. So, while during interviews, Wireless Leiden participants might perceive to be engaged in a front-stage performance Wireless Leiden to a public (of innovation students), engaging in fierce debate on a confined mailing list is perceived a back-stage activity.

motivations behind volunteer contributions. Or in sociological terms one could explore the issue of collective action within common-property resources. However, instead of exploring matters 'purely' psychologically or 'solely' sociologically, I take matter itself serious in my analysis. Elsewhere, Latour (1992) famously argued about technology as the missing masses in sociology. However not technology itself, but how it becomes enacted in practices (Orlikowski, 2000) will serve as starting point for understanding why actors gain, maintain or loose interest in community-based innovation. This approach does not exclude participants' views, opinions or interests from the analysis, as these 'cultural' elements are equally important as the 'material' elements in stabilizating the hybrid collectives emerging in the process of community innovation. For example, in the first empirical chapter we saw how the visionary promise of populating a new wireless Wi-Fi frontier by growing grassroots infrastructures, functioned as a powerful method for mobilizing resources and interesting and aligning actors. In the second empirical chapter, the role of the press was important as an intermediary for conveying representations of Wireless Leiden as potentially interesting free alternative for commercial Internet Service Providers. Nonetheless, neither of these chapters made explicit how different actors valued the practices in which they were participating.

One thing is clear however, in the case of community innovation the pay-off for participation is not primarily financially motivated. In their roles as unpaid volunteers, participants are not in it for the money. Or, at least, not in the first place. However, this does not imply there is no economic value involved in community innovation. The important message here is that community innovation cannot be reduced to its economic value. Zooming in exclusively on the value of entrepreneurial activities in community innovation settings, renders other important activities and values invisible, which cripples a broader understanding of the dynamics of these kind of innovations. In the case of community innovation actors cannot be reduced to a 'homo economicus'. Certainly, entrepreneurial activities play an important role, for actors engaged in community-based innovation. However, at the same time, these actors could be described as 'homo ludens'(Huizinga, 1955). An important aspect of how actors value community innovation practices is how they experience them. And this is where lots of non-economic values come to play an important role. To summarize, framing the value of community innovation purely economically, is, in a sense, to miss its raison d'être, as it is by definition characterized by multiple values. This raises the question of what other types of values could aptly capture what community innovation practices are about.

5.1.2 Valuing technology practices

To analyze the values that are at stake in Wireless Leiden, I mobilize Arnold Pacey's work on "the values of technology-practice" Pacey (1983). Although his essay predates most material-semiotic technology studies, it nonetheless fits in quite well with that approach, due to the explicit focus on practices, taking into account all actors involved, granting agency as well to technological

artifacts and material environments.[2] Pacey's argument is that innovation practices should be understood as a combination of distinct types of locally enacted "practices of technology". These technology practices can then be clustered into three categories, grouped around 'sets of values', including *economic* values, *virtuosity* values, and *user or need* values. Additionally, Pacey asserts that technology-practices are enacted in different 'spheres of technology'. The *expert sphere* is populated mainly by paid professionals such as designers and producers, whereas the *user sphere* is populated by users, consumers and workers-as-users. Broadly sketched, economic values and virtuosity values characterize the expert sphere, while user or need values characterize the user sphere. Most importantly, Pacey emphasizes the effort involved in handling these different values in innovation practices. Even more so in periods when these different values clash. Interestingly, he does not argue that value-conflicts should be considered as something negative, or something that should be prevented. Instead, Pacey suggests that innovation processes should give room to 'multiple voices' Pacey (1983, 141). In his view, multiplicity is necessary to improve the innovation process. An improvement, not meant quantitatively, but qualitatively, by balancing the wider set of economic, virtuosity and user or need values.

Although Pacey's approach articulates a normative agenda, I will use Pacey's three categories of values mainly as sensitizing concepts to analyze the different values articulated in debates within Wireless Leiden and the work involved in balancing these values.[3] My point of departure is that handling the multiple values requires a new type of labor: *coordination work*.[4] Coordination work is the term I will use to refer to the activities involved in keeping the hybrid collective of Wireless Leiden coherent and preventing it from falling apart,

[2] Both Pacey's theoretical analysis of technology-practices (Pacey, 1983), as well as his hands-on manuals for "appropriate technology" Pacey (1977a,b, 1978, 1980) are of interest to students of technology use working with a material semiotics approach. However, his work is usually not referenced in user studies reviews or material semiotics literature. Therefor, this section can also be read as a modest Pacey revaluation project. Although at first sight, this work might seem outdated regarding its publication date in 1983, its stress on "values" as central organizing principle, and its lack of advanced theoretical concepts compared with newer and conceptually more advanced 'actor-network theory' and 'after-ANT' literature (Law and Hassard, 1999), this rarely cited work, in my view, nevertheless offers an apt analysis that still holds true today, and is especially relevant in the context of community innovation. Nonetheless, in my view, Pacey's theoretical approach based on careful observations of geographically and temporally situated "technology-practices" enacted by mixtures of humans and things, is more-than-enough compatible to function as a valuable starting point. Surprisingly, even his graphical depiction of an "outline map of technology-practice" (Pacey, 1983, 49), to me seems quite similar to schematic "actor-networks" featuring in papers of more recent dates. In my view there are some central elements in Pacey's approach that makes it still valuable to the field of Science and Technology Studies today, although his conceptual framework is sketched out in very broad lines. Nonetheless, Pacey's work is firmly rooted in previous empirical research based on detailed knowledge of and personal involvement in projects on "hand-pump maintenance" (Pacey, 1977a), "gardening for better nutrition" (Pacey, 1978), or "rural sanitation" (Pacey, 1980). This enables the construction of linkages between localized practices of technology and generalized values of technology.

[3] The use of a 'sensitizing concept' as heuristic device for analyzing empirical data is described in further detail within the grounded theory approach pioneered by Glaser and Strauss (1967).

[4] The notion of coordination work is introduced in Mol (2002), and provided an important source of inspiration for this chapter.

effectively handling the multiple values. To coordinate as verb embodies two related, but slightly different meanings, something which nicely captures the inherent friction of this type of work. The first meaning is to work together harmoniously, which implies a democratic organization in a horizontal plane. The second meaning is to bring in order, which implies hierarchy, in a vertical plane. Irregardless if the vectors of coordination forces are fully horizontal, fully vertical or somewhere in-between, both meanings share the aim at aligning the multiple values to add up to, instead of subtract from, the strength of the hybrid collective.

Summarizing, this chapter aims to address the following question: *What actors, strategies and activities are involved in the coordination work to maintain coherency, despite conflicts emanating from the articulation of multiple values of community innovation?*

To answer this question, I analyze debates that took place on the volunteer mailing list of Wireless Leiden in the period between 2004-2008. I chose two periods of fierce debate and controversy on what values should be prioritized in Wireless Leiden. The first controversy is on the issue of commercial activities within Wireless Leiden, which mainly took place between the end of 2004 and the beginning of 2005. The second controversy is on professionalization of Wireless Leiden, and took place between the end of 2006 and the beginning of 2007. The choice of these two periods of the mailing list enables me to compare the different strategies applied in coordination work with their outcomes. What strategies work, or not, to prevent the destabilization of community innovation in periods of friction and controversy on the multiple values of community innovation?

The structure of this chapter is the following: First, in section 6.2, we follow how board members of the Wireless Leiden Foundation started articulating the importance of economic values, and the rhetorical strategies they employed for influencing the agenda of the broader group of involved actors. Secondly, in section 6.3, we study in detail the emergence of the value-conflict on commercialization, and the strategies for mitigating the destabilizing effects of this controversy. Thirdly, in section 6.4, we study a second controversy in detail; this time about professionalization. In order to prevent repetition, the main focus will be on the differences in strategies for handling value-conflicts. Finally, in section 6.5, we assess the effectiveness of different strategies of coordination work for handling value-conflicts, based on the dynamics of the two controversies. Special attention is paid to the discovery of a fourth type of values, which seem strongly attached to community innovation, and also particularly impracticable to mix with economic values.

5.2 Introducing economic values

In the Wireless Leiden collective, multiple actors are involved in the 'doing things together' which the process of community innovation work.[5] The actors

[5]The phrase 'doing things together' is inspired by Becker (1986).

are guided in their practices by different rules for action, rooted in multiple interests, aims, values, beliefs and visions. However, until this empirical chapter only two of the three values described by Pacey have been addressed explicitly until now, virtuosity values and user or need values.

The *initiators* of Wireless Leiden, were mainly concerned with virtuosity values. They were primary interested in assembling a novel wireless networking infrastructure (see chapter 2, Alignment work). The *explorers,* in this case the Wireless Leiden volunteers, were also mainly concerned with virtuosity values. Once Wireless Leiden was established, this type of actors could use it as a 'technological playground'. For these actors the Wireless Leiden collective offered a stage for performing masculine identities rooted in the 'pleasures and powers' of mastering technologies *(*see chapter Care work). The *extenders*, in this case the home-users and organizational users, had other concerns. They valued the Wireless Leiden collective in terms of user / need values, as their main aim was trying to get their particular needs addressed. For example the user need to connect personal computers to a local 'zero-cost Internet', to surf the web fast and free (see chapter Domestication Work). Organizational users were mainly interested in a fast and cheap way for a city-wide local area network (LAN) enabling digital communication between offices at different locations, for example by employing secured VPN-connections (see chapter Alignment work).

Until now economic values have been back-grounded in analyzing the case of the Wireless Leiden collective. Time to address this lacuna, for economic values had been on the agenda of the Wireless Leiden collective even before it had named that way. However, the initiators realized that a grassroots infrastructure such as Wireless Leiden could only be realized as non-profit cooperative. For developing such a bottom-up collective economic values were considered not important. Even worse, economic values might even repel non-financially motivated actors from becoming involved as unpaid volunteers, or granting access to install node-hardware on their homes for free. However, once the 'Wireless Leiden model' proved to be viable, this changed and economic values reappeared on the agenda. Once Wireless Leiden turned into a 'success' actors were no longer interested in experimentation rooted in virtuosity values, but became also interested in exploitation rooted in economic values. A new type of actors emerged: the *exploiters*. In short, this group mainly consisted of board members and Wireless Leiden volunteers actively involved in their own IT-related commercial and entrepreneurial activities.

One of the first examples of an actor interested in exploitation and the economic values of outdoor Wi-Fi was radio-amateur Johan de Stigter. Already during the initiation of Wireless Leiden, in 2002 De Stigter founded the company Gandalf — "the Wi-Fi antenna specialist" — selling weatherproof outdoor wireless hardware.[6] The company Gandalf addressed a lacuna in the market, namely the user need for specific devices which at that point were not easily and economically available, certainly not in the Netherlands, or even Europe

[6]Quote from 29-10-2002 snapshot version of http://www.gandalf.nl at the Internet Archive Wayback Machine.

Figure 5.1: Commercial Wandy client

as a whole. One of the successes of this company was its introduction of the so-called Wandy (see figure 5.1). This device was a commercialized version of the 'rain-pipe client' (see figure 5.2 on the following page) developed by Wireless Leiden volunteers as a cheap solution for connecting home users to the Wireless Leiden. However, Gandalf offered a version, that was an all-in-one ready-made, technologically robust and user-friendly, specifically catering to the needs of home users instead of technical hobbyists for whom exactly the aspect of assembling things yourself was made Wireless Leiden so attractive. In addition, Gandalf was also one of the main suppliers from which Wireless Leiden bought their hardware. This was a win-win situation. Gandalf gained Wireless Leiden as a 'big' customer enabling to buy its stocks in bulk. Also it offered a free advertisement platform, offering free publicity. Wireless Leiden had a hardware supplier that could relate to their specific needs and demands, while

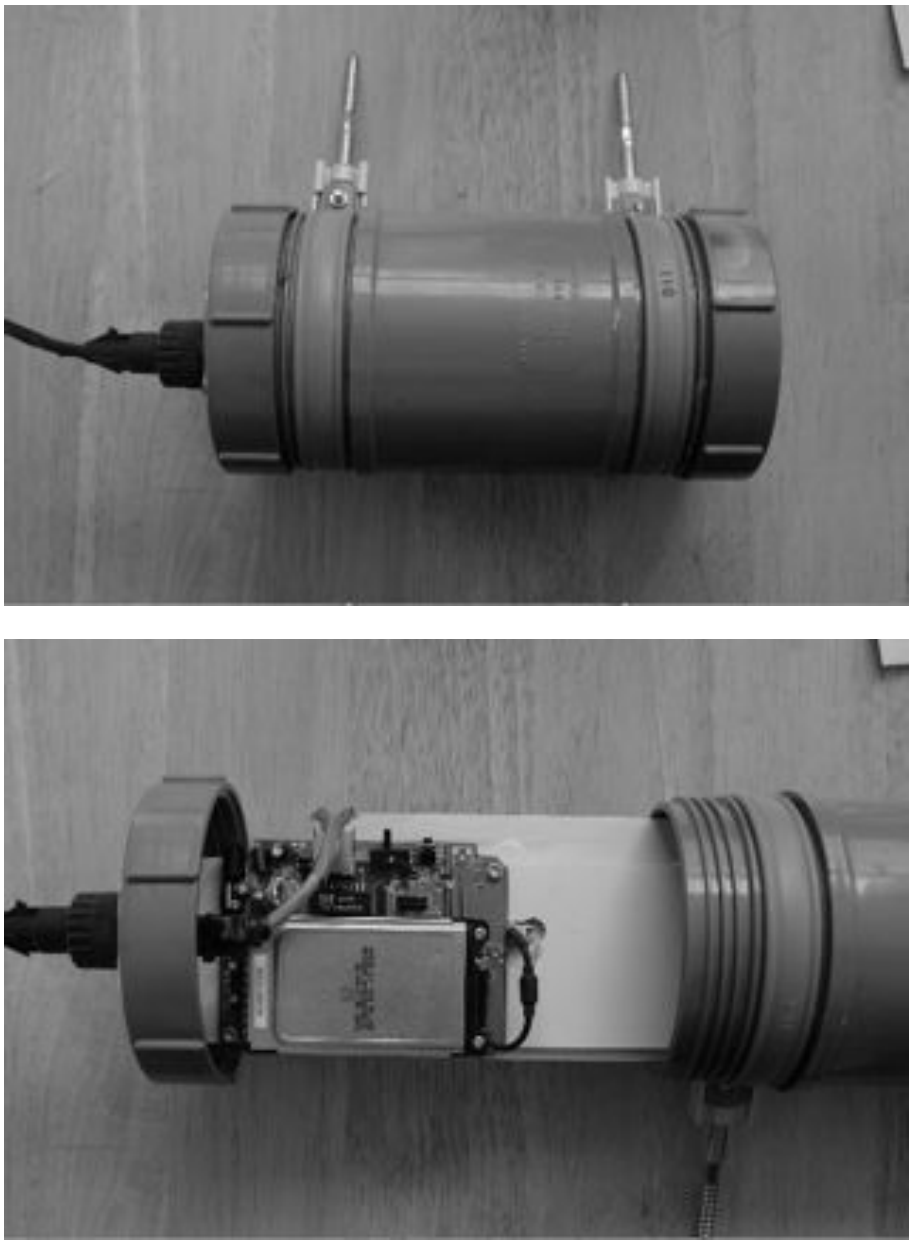


Figure 5.2: Build-it-yourself rain-pipe client

also providing significant price discounts. For Wireless Leiden volunteers not really interested in servicing home users and solving their connection problems, the commercial availability of the Wandy in November 2003, provided a perfect solution to which these tasks could be delegated as a 'plug-and-play' device.[7] All in all, this cooperation between the for-profit Gandalf and not-for-profit Wireless Leiden worked fine.

However, the main ingredient for this arrangement to work without friction, involved a clear boundary between the two main actors. Gandalf was not active within Wireless Leiden, but only as an external actor. The moment his company started to gather momentum, its owner Johan de Stigter slowly became less involved with Wireless Leiden. As his commercial involvement in Gandalf increased, his volunteer involvement in Wireless Leiden decreased. Later, the distance even literally increased, when his company relocated to another location offering better conditions in term of rules, rent and space. For Johan de Stigter and his company Gandalf, Wireless Leiden had served as a launching site, but now he had enough other customers to operate separately from it. In short, Gandalf never was part of the space within Wireless Leiden, in the sense that he did not interfere directly with technology-practices of other Wireless Leiden participants. So, this specific company never exploited Wireless Leiden itself. Instead, Wireless Leiden functioned first as a source of inspiration for novel products, while doubling as target market for these products as well. These strict boundaries might thus explain how in this particular instance commercial exploitation — in this case of the economic value of outdoor Wi-Fi solution — was possible without any value-conflict with and within Wireless Leiden.

However, Johan de Stigter was not the only actor with entrepreneurial ambitions for exploitation of the economic values of Wireless Leiden. Other volunteers, besides being involved in Wireless Leiden, were also involved in Wi-Fi related entrepreneurial activities. This brings us back to the interview with ex-Wireless Leiden volunteer Hugo Meiland in section 5.1 Meiland urged me to look into commerce-related conflicts. He specifically pointed to the fact that there were never made clear rules for dealing with commerce *within* Wireless Leiden. So, this raises the following question: Where, when and how made economic values of Wireless Leiden their appearance on the agenda?

5.2.1 Discussing why: the growth imperative

One of the first times economic values (re)appear on the agenda within Wireless Leiden is in December 2003. On a Friday evening, the chair of the Wireless Leiden foundation, sends an e-mail to the volunteer list:

> Subject: The future of Wireless Leiden
>
> Dear all,
> I feel that within the next months Wireless Leiden will face critical choices, which, either made implicitly or explicitly, will strongly

[7] Source: November 2003 Wireless Leiden press release.

> influence the future of the network. Some of these choices are mutually dependent.
> Some examples of choices:
> * Further professionalization / remaining a hobby network
> * Paid (Internet) services or not
> * Professional network administration or not
> * Commercialization of knowledge and experience apart from the foundation or not
> * Leiden stays ahead in Wi-Fi (leading the way) or marginalizes
> * Will it remain possible to run everything by volunteers or are some matters so time-consuming they can only get dealt with by paid workers?
> I will try to create a more complete discussion piece. Our lawyer volunteer wrote an exploration from a legal perspective.
> Because the network is first and foremost a matter of volunteers, I would like to invite you for a meeting at my house next Monday at 20:00, to argue on these matters over a cup of coffee & rusks with aniseed comfits.[8] Could you let me know if you plan to come over?
> Cheers.[9]

I quote this message completely, as it offers a particularly clear forecast of the conflicts about the economic values of Wireless Leiden in general, and the activities of commercialization and professionalization in particular. Therefore, it is important to study in detail how economic values reappeared on the agenda.

The rhetorical strategy employed is threefold. In the first place, it consists of a strategy of reduction: multiple options are translated into a single one, namely the imperative to growth. Sure, alternatives are theoretically possible, but all of them equal failure, so in practice they are not feasible. At least not, for anyone really caring about Wireless Leiden and its future. This strategy of reduction is reinforced by framing this e-mail as an informal scenario-study, or at least setting the agenda for it. All future instances of Wireless Leiden are reduced to two single coherent instances: a successful Wireless Leiden and a marginal Wireless Leiden. This way, the current multiplicity of Wireless Leiden is translated into a single either/or dichotomy: either success by growth, or failure by stagnation. Current community innovation practices are pressed into an ideal-typical mold of commercial innovation practices. The implicit message is that only a commercial innovation journey, involving professionalization and commercialization, enables further growth and success. Stating that these choices are "mutually dependent" also reinforces the idea of a dichotomy, toning down the possibility of alternative scenarios. As such, this e-mail message is a skillful attempt to interest and translate Wireless Leiden volunteers into participating allies for reshaping WL into an entity suitable for and compatible with the economic values of commercial innovation.

[8] Offering your guests rusks with aniseed comfits is a Dutch tradition to celebrate the birth of a child; in this case the one-week-old baby of the chair.
[9] Source: Wireless Leiden volunteer mailing list Jasper Koolhaas, 2003-12-12.

In addition to the strategy of creating a dichotomy between failure and success, there is second rhetorical strategy at work in this text, namely creating a sense of urgency. As the author states, this particular issue has to be dealt with rather soon, namely "in the next few months". Acting has to be soon, because the choices to be made are "critical" because they "will strongly influence the future of the network". Making no choice at all, equals the wrong choice, because taking no action will cause Wireless Leiden to wither away into obscurity.

Finally, the third strategy consists of a clever move in which the author makes all participants personally responsible for and actively involved in the failure or success of Wireless Leiden. By adding the remark that a choice will be made anyhow, either "implicitly or explicitly", the author suggests that by remaining silent, withholding from discussion or not voting, participants are nonetheless fully responsible for the outcome. In this sense, not making a choice, counts as a choice for failure. In order to persuade volunteers to participate in this choice their importance is stressed by suggesting that "the network is first and foremost a matter of volunteers". In order to leave room for contributions to the debate by volunteers, the author uses a cautionary clause. This way the author stresses that this message is not complete, but contains only "some examples of choices" implying anyone can add to the agenda. The message ends by comforting any possible worries about the nature of the discussion itself. No, it won't be a fierce debate, but an amiable get-together organized in the cozy confines of the chair's home, with the organizer serving coffee and biscuits.

Although rhetorically convincing, this message is clearly written from the board of the Wireless Leiden foundation. This perspective needs not be similar to or completely overlap with the perspectives of the other Wireless Leiden volunteer participants. So let us take a look at other actors involved in Wireless Leiden.

5.2.2 Discussing how: the wireless cluster

Interestingly enough, both wishes for exploring Wireless Leiden as a technical playground and for exploiting its economic potential into commercial activities, emerged from the volunteers who were most actively engaged in Wireless Leiden, in terms of time and commitment. Most initiators later-on became board members of the non-profit foundation. These actors actively attempted to handle frictions between virtuosity values and economic values of technology-practices within Wireless Leiden. The first strategy for doing so, consisted of a strategy of sorting out economic values from virtuosity values by relocating economic values outside the confines of Wireless Leiden.

As most of these core actors were still, or had been, professionally involved in the domain of information and communication technology, their understanding of innovation was shaped accordingly, as a layered process in which different elements had different values. By any means, the initiators of Wireless Leiden had a nuanced vision on the relation between on the one hand its basic technical wireless infrastructure based on open source software and open standards, while

on the other hand the potential for commercial services layered either on top of this infrastructure or in the form of spin-off companies. This hybrid web of communal infrastructure (as commons) and (proprietary) commercial services mirrors the architecture of the Internet at large with its different layers of privately owned physical hardware, public domain routing protocol software (e.g. the TCP/IP stack developed for BSD-Unix)[10] and bottom-up developed and freely accessible open standards in the form of 'request for comments' RFCs[11], commercial ISPs and finally both non-profit as well as for-profit services.[12] The fact that the initiators of Wireless Leiden modeled their vision of the wireless community innovation project on the Internet as successful example of hybrid communal-commercial innovation, comes as no surprise recalling that most of them had a history of being professionally employed in Internet-related companies or otherwise deeply influenced by the Internet culture of anarchistic hackers, entrepreneurs, virtual communitarians, and techno-meritocrats.[13]

It is important, to note that for the initiators of Wireless Leiden there need not be an a priori incompatibility between communal and commercial activities within and outside a distributed innovation based on an "open source" approach. However, at the same time, these actors shared the consensus that specific parts of a distributed innovation project have different 'affordances'[14] in relation to their suitability for either communal or proprietary ownership and development. More specifically, the different parts of the physical infrastructure (in the form of specific nodes) might be privately owned, but should be running 'free software' based on 'open standards'. In a similar manner, individuals might make money by offering commercial services layered on top of the volunteer effort of developing a basic infrastructure. From the very first conception of Wireless Leiden it was clearly understood that in order to interest and enroll local actors for creating a strong coalition, in this specific case, a non-profit approach was the best strategy. Due to the fundamental characteristic of the 'ether' as common-pool-resource located in the electro-magnetical spectrum, it was envisioned that setting up an networking project based on a communal architecture was the only strategy that had any chances for success at all (see chapter 2, Alignment work).[15]

[10] For a concise history of BSD-Unix see DiBona et al. (1999).

[11] On the history of the Internet see Abbate (1999).

[12] This layered architecture of the Internet and its consequences are elaborately developed in Lessig (1999, 2001).

[13] On the culture of the Internet, see Castells (2001, 37): "The Internet culture is characterized by a four-layer structure: the techno-meritocratic culture, the hacker culture, the virtual communitarian culture, and the entrepreneurial culture."

[14] For the notion of affordances see Hutchby (2001).

[15] Different sources (such as consultants, researchers, user-innovators) all agree on the fact that for setting up Wireless-Area-Networks such as in the case of Wireless Leiden, Wi-Fi is almost impossible to deploy commercially. Due to the limited range of Wi-Fi technologies, caused by the legally allowed very low maximum emission powers, requires a very high number of nodes to cover a certain geographical area, which then causes high costs of running and maintaining such a network (source: personal communication with Hendrik Rood, researcher at TU Delft and telecom consultant at Stratix Consulting, 2006-03-17). However, as different cases prove, bottom-up volunteer-run efforts are possible, factoring out labour costs, deploying low-cost hardware, zero-cost software and free use of rooftops.

In May 2004, the first traces become visible of work involved in what could be termed a process of sorting, in an announcement on the volunteer list. In this message, one of the board members initiates an attempt to relocate commercial activities outside Wireless Leiden, under the heading of "wireless cluster". This name makes explicit the underlying sorting mechanism for 'clustering' together economic values of Wireless Leiden. It is noteworthy however, that these activities no longer take place under the banner of Wireless Leiden.

> Subject: commercial activities and wireless cluster
>
> The following is to inform everyone, and for those owning a company or active interest in starting commercial activities to reply to (offline please). Facilitating and stimulating commercial activities is one of the aims of Wireless Leiden. Furthermore, I myself, think that commercial activities are very important for a sustainable Wireless Leiden. Commercial activities can be using the Wireless Leiden network for offering or selling commercial services, consultancy, administration or products. [...] A cluster is defined as a network of companies and supporting infrastructure (services, research, education, government). Participants profit from each others knowledge and relations (technology, market). The exemplar is Silicon Valley. [...] Our first step is to establish a legal entity. [...] Please, respond off-line!

When reading this message a few remarkable things stand out. In the first place the fact that although the message itself is announced on the volunteer list, it is very clearly expressed (twice actually) that a follow-up discussion should not take place between and within the confines of the volunteers, but as private mail conversation. This can be considered as a clear strategy of compartmentalization, in which a separate 'space' is set up for interaction between actors with commercial interests in the form of a "wireless cluster", bearing a different name, and preferably also as a distinct legal entity. Secondly, Wireless Leiden is plugged into a specific discourse of innovation; one that is modeled after the historical success of Silicon Valley. This is what is being framed as such by introducing the notion of 'cluster'. Adding to this, Wireless Leiden as 'innovation project' is framed in terms of its economic values for the Leiden region.

It is very interesting to see a kind of 'inverse' boundary work enacted by Wireless Leiden board members.[16] Instead of keeping 'core activities' within the boundaries of Wireless Leiden, these important activities are relocated outside Wireless Leiden. However, most certainly the effort is aimed at clearly demarcating 'commerce' from 'commons'. Framing Wireless Leiden in this regard as infrastructure, kind of mirrors the dominant discourse on innovation, framing the way in which entrepreneurs operating in economic markets are supposed to valorize the work of academics working within 'pure science'. So,

[16] The concept of boundary work is introduced by Thomas Gieryn Gieryn (1983). In a later publication Gieryn (1995) aligns his own research on demarcating science from non-science, with the more general 'sociology of professions' by Andrew Abbott Abbott (1988).

in the case of Wireless Leiden, not only a process of sorting is involved, but a process of 'purification' as well, separating the 'virtuosity values' from the 'economic values'. Perhaps, a reason for this inverse boundary work is that although economic values are very important for the future of Wireless Leiden, they do not particularly fit in very well with the carefully crafted imago of the 'brand name' Wireless Leiden as a non-profit foundation. Also it is the non-profit imago of Wireless Leiden that enables free access to the rooftops of Leiden citizens and the time and commitment of unpaid volunteers. Perhaps, the different values of commerce and commons, just like the different fluids of oil and water, just don't mix very well. One can shake as hard or long as possible, but inevitably a boundary between the two emerges. Volunteer actors seem mainly interested in virtuosity values, while entrepreneur actors by definition are attracted by economic values. Especially when actors play multiple roles of unpaid volunteer and paid entrepreneur simultaneously, value-conflicts seem just around the corner.

5.3 Coordinating the value-conflict on commercialization

In the previous sections we have seen how economic values are introduced on the agenda of the Wireless Leiden collective in 2004. Actually, commercial activities had been clearly visible since august 2002, when the Wireless Leiden Foundation was established. The official document mentions explicitly that one of the main aims of the foundation is to stimulate and facilitate economic activities related to wireless. However, with the emergence of the "wireless cluster" in 2004, commerce was no longer something important in theory but something very real, consisting of very concrete business practices.

Rhetorically, the vision of stimulating and facilitating commercialization is firmly entrenched within an economic imperative of progress, growth, and success. And who could ever be against such universals of modernity? However, that is exactly what happened. Not all Wireless Leiden participants shared the board members primus-inter-pares attitude towards economic values. Especially since volunteer activities did not primarily follow an economic logic. In this section I follow how volunteers articulated what they valued most. In addition I analyze how Wireless Leiden coordination work mitigated the destabilizing effects of the first value-conflict.

5.3.1 Internal actors interested in the economic values of Wireless Leiden

To understand how the value-conflict on commercialization emerged, we need to get a clearer image of the actors involved. In short, all actors had the status of official Wireless Leiden volunteer. However, volunteers can play different roles at the same time. In relation to the conflicting views on the economic values in Wireless Leiden, three different types of volunteers stand out.

In the first place, as described previously, economic values were introduced by the actor type I labelled initiators in Chapter 3. Most of these actors became board members when they gave birth to the Wireless Leiden Foundation in 2002. This sub-group of Wireless Leiden volunteers thus gained special privileges to act as spokesperson and representative. Their board membership enabled them to clearly express their wish for exploiting the economic value of Wireless Leiden by setting the agenda. From their perspective as board members, adding a commercial layer on top of the communal infrastructure, was the only way to further translate nifty inventions into true innovations. Nonetheless, from the perspective of the board, it was the future of Wireless Leiden on a collective level that was at stake, and in need of taken care of.

Starting in 2003, a second sub-group of Wireless Leiden volunteers had grown interests in exploitation as well: the volunteers with entrepreneurial interests and commercial activities. However, this subgroup differed with the board members in terms of the localization of commercial activities. For this subgroup, the importance of commerce was placed not so much at a collective level, but much more at a personal level. Roughly at the same time when Wireless Leiden morphed into a legal entity in the form of a non-profit foundation, these entrepreneurs started their own private companies. At least, if these companies had not already existed, prior to their owners involvement with the Wireless Leiden community innovation.

It is important to notice that in practice, these two sub-groups of volunteers were not so clearly distinguishable as perhaps in theory. Actors involved in Wireless Leiden often play multiple roles, sometimes simultaneously, sometimes sequentially. For example, some board members were also active entrepreneurs in relevant areas such as computer networking, embedded devices hardware or IT consultancy. As we saw in chapter 3, this rich diversity of actors enabled Wireless Leiden to succeed in their heterogeneous engineering activities of aligning human and non-human actors. As we saw the 'social engineering' involved in interesting and aligning home users, rooftop owners, sponsors, press and local government into the Wireless Leiden actor-world was equally important as the 'technical tinkering'. Additionally, the first activity involved at least as much concerted engineering genius, effort and care as the second one. In short, there was considerable, but no complete, overlap between Wireless Leiden initiators and exploiters; and between explorers and exploiters.

Finally, a third relevant subgroup of Wireless Leiden volunteers can be discerned: volunteers without any entrepreneurial ambitions whatsoever. For these volunteers their active involvement in Wireless Leiden was purely a leisure activity, how 'serious' it might be. Especially important is that for this specific sub-group, the pay-off consisted of constructing identities out of technological virtuosity, instead of creating business.

Summing up, there are: volunteer | board-members, volunteer | entrepreneurs, and volunteer | amateurs. All volunteers, however with different roles, these actors respond differently to the strategy for handling commerce by setting up the Wireless cluster as a separate space for exploitation, parallel to Wireless Leiden as a space for exploration. The role of Wireless Leiden volunteer | board-

members for thinking out such a space conceptually and initiating it practically is clear. The role of volunteer | entrepreneurs for populating it, is clear as well. But what about the volunteer | hobbyists? How do these plans and actions influence their own technology-practices, suddenly separated from other types of volunteers? Do the boundaries demarcating the spaces of commerce and commons work in practice, or yield frictions instead?

5.3.2 Coordinating Commercialization

In September 2004, some volunteers start to articulate mixed responses to the strategy of compartmentalizing economic values by expressing their questions, concerns and irritations on the volunteer mailing list. It is here, that different 'threads' emerged on the volunteer mailing list , discussing commerce and its discontents. Soon these different strands merged together into a broader debate on the issue of handling commerce within Wireless Leiden as community-innovation. To provide some background, I shortly summarize the discussions in the different threads that sparked a broader discussion, taking place mostly on the volunteer list and partly on the technical list.

The first thread is about a 'trial' with a commercial Internet Service Provider (ISP).[17] It involves a test in which customers of the commercial Internet Service Provider gain full access to the Internet in their homes via outdoor Wi-Fi. The role of Wireless Leiden is providing the last-mile connectivity between hcc!net servers and home-users PCs. For the ISP in question the trial offers an inexpensive test bed for gaining experience with Wireless ISP activities. The novel aspect of this trial is that for the first time commercial services are offered over the Wireless Leiden network. However, the arrival of external commercial actors into Wireless Leiden also introduces 'commercial-grade' expectations about the reliability of the network. As long as home users can use Wireless Leiden for free they are much more forgiving in case of temporary malfunctions. However, once their money flows into the network, they demand a certain level of quality in return. Paying customers expect something that works reliably in return for their money; if not they first start complaining, and then stop paying. In contrast, volunteers, are concerned about their freedoms to tinker and experiment even when that means a temporary failure of some parts of the network. Therefor volunteers fear the negative consequences of the introduction of commercial services, and subsequent demands for reliability, meaning less freedom in their everyday technology-practices.

The underlying issue is thus how commercial services raise expectations about a certain degree of 'service-levels' in terms of reliability and responsiveness in case of failure in a situation where these services run on top of a 'bottom-up' infrastructure, operated and maintained by non-paid volunteers. A

[17] The ISP in this case is HCC!net, which is a commercial Internet Service Provider in the Netherlands. Ironically, HCC!net itself emerged as a commercial entity from a non-profit organization, namely the Dutch 'Hobby Computer Club' (HCC). Perhaps one of the dynamics of community innovations is to develop into commercialized and professionalized organizations, in which user / need and virtuosity values become subordinate to economic values.

common solution for open source software to make available a 'stable' version for everyday use and also a 'development' version for experimentation is not possible, or much more difficult to implement, if material infrastructures are involved. So in the case of Wireless Leiden, this means making choices of whether to prioritize the user values demands by focusing on exploitation activities or the technical virtuosity values by focusing on experimentation practices.

The second thread is about how to create a wireless connection to a digital camera mounted on an airborne Zeppelin. It involves an external individual asking for help for addressing a specific outdoor Wi-Fi need for which no commercial solutions is available yet.

The third thread starting in September 2004 as well, is discussing cooperation with another Leiden-based non-profit foundation called Soundnet. This organization would like to make use of the physical locations of Wireless Leiden nodes to install their own hardware devices to measure airplane noise in a distributed manner and send the data real-time over the wireless network.

Although all three threads start on different topics, their contents converge towards the same underlying issue of dispute, namely how to deal with commercial activities within Wireless Leiden. In this fourth thread, discussions no longer deal with concrete projects, but directly target more abstract themes such as "core values", "vision on the future of the network", and "Wireless Leiden and commerce".

Just to give an idea of the importance of this debate, of the total of 297 messages on the volunteer list in September 2004, 85 posts were on the topic of commercial activities. This is almost thirty percent of the total traffic on that list for that particular month. Such a percentage clearly shows that the volunteers perceive this to be a relevant issue, worthy to give voice to their opinions.

As we have seen in the previous section, the main strategy to deal with the economic values in the Wireless Leiden community innovation was to set up different spaces for different types of technology-practice. In short, a strategy of compartmentalization: Wireless Leiden as non-profit foundation for commons-based innovation practices, the Wireless cluster for commerce-based innovation practices. Although in theory this compartmentalization strategy seems a simple and effective approach, in practice things prove to be more problematic. Especially as actors and their activities in practice continuously overflow the theoretical boundaries of the two distinct technology-practice spaces. In order to make the strategy of compartmentalization effective, additional strategies for coordination work seem required as well.

5.3.3 Coherence-in-tension

Time to take a closer look at the data, to see how three types of value frictions developed in the threads and, subsequently to analyze what strategies of coordination work are involved in managing the potentially destabilizing situation of 'coherence-in-tension'.[18] In these interactions it is not only important what is discussed, but also how and by whom.

[18]The notion of 'coherence-in-tension' is developed in Mol (2002).

Friction on ordering values

The first type of friction is related to a strategy of distributed decision making about ordering values. More specifically, the question is on how to focus activities within community innovation: how to decide and by whom? In the thread about the hcc!net trial, we can see examples of frictions about what types of activity are considered most important. Board members are mainly focused on the development of Wireless Leiden on a collective level. In their view, interesting external actors and making them invest in the network is a good thing, as it strengthens the network. For example, if the external corporate actor HCC pays for setting new nodes and improving current nodes, then this is beneficial for the whole wireless infrastructure. Hence from the perspective from the board, activities involving interesting and aligning external actors are highly important and valuable.

Regular volunteer | amateurs, however, have a different view. Their interests are primarily targeted at the possibilities for technical experimentation. In their view providing commercial services requires a stable network, which in turn constrains possibilities for experimentation. To summarize, at stake here are two different interpretations about which values are more important for Wireless Leiden. Which in turn lead to questions about distributed decision in case of such contested matters.

Differences in ordering values have serious consequences for focusing activities on the development of the network design, as well as for the deployment of scarce resources such as volunteers limited free time. For example, one board member clearly articulates that the user values of the network are not primarily an end in itself for experimentation purposes only. More importantly, the network is a means for enabling different types of use during which the underlying Wireless Leiden technologies itself fades away into the background. An analogy is the plumbing in the wall of other taken-for-granted infrastructures such as water, electricity, gas, or telephone supplies. The value of such technologies is not the plumbing or cabling in the wall, but the use practices they enable, such as heating or cooking. Or stated as a rhetorical question by the board member:

> "The value of the network is in its use, what do you actually do with it?!"

The problem with this statement however, is that in the case of Wireless Leiden there is no single use, instead there are multiple uses. Different actors, moved by different interests, are enacting different practices of use in interaction with the network. To acknowledge this multiplicity, the board member acknowledges this diversity of uses by clarifying his previous statement:

> "The use is: local traffic (e.g. for schools, library, local communication), Internet access (for people at home, especially those who are not able to subscribe to or afford a fixed telephone line). And then finally: a playground for nerds, education/research, product development, etc."[19]

[19]Regarding 'nerds': the Dutch word "techneuten" was used here. Usually this term means "technical

Interestingly, in this short quote we can identify the articulation of the three values of technology-practice as categorized by Arnold Pacey. User or need values in the form of "local traffic" or "Internet access"; virtuosity values in the form of "playground" for "hobbyists" or "education/research", and economic values in the form of "product development".

However, this particular ordering – especially note the use of the word 'finally' – of the different practical values of Wireless Leiden, raises concerns amongst volunteers. In the first place, the importance of the user values of Wireless Leiden is not shared at all by some volunteers. Or, as the volunteer initiating the debate articulates:

> "This was not intended. [Wireless Leiden] is a network, and not some kind of sophisticated zero-cost Internet access."

Others back up this position:

> "I don't agree with the opinion that Internet is essential for Wireless Leiden. It might be convenient for public relations, but at the same time brings in a lot of complaints/noise in case of malfunction. Wireless Leiden is no ISP [Internet Service Provider]."

In this specific articulation, the pejorative undertone towards framing user values in terms of home users is meant to show that these values should be given a low order in terms of relevance and importance. One volunteer makes this explicit by recommending the original poster:

> "[Y]ou should change your text in the following: 'in the first place playground for technicians' and in the last place Internet for people at home."

In order to mobilize support for this particular ordering of the multiple values of Wireless Leiden, this volunteer refers back to the December 2003 discussion meeting about the future of the network:

> "There has been a special meeting at Jasper's home about the future of the network, at which it was exactly decided it should remain a playground."

What then happens is that the debate shifts its focus away from a discussion about the particularities of setting up a trial with paid Internet services, towards a more general debate on how to decide what values are important, and how to take decisions on such matters. One volunteer states that one should be able to maintain some values as fixed, for example as decided upon in the foundation articles. A board member replies as follows:

> "That is way to rigid. Founding principles as a basis are OK, but even those can be changed. Translation into 'policy' is by nature

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people", however with a slight pejorative undertone. However, the term is also used as a proud nick name by such technical people themselves. Especially within the context of Wireless Leiden, this word is used to distinguish knowledgeable people from "clueless" ones.

> much more flexible: that is something we decide on from year to year (policy plan). One fixed value is — in my view — that we together shape our course. And it can and will change: the world changes and the group of volunteers changes. [...] Considering this course: we can think up anything, but in the end volunteers themselves decide what they want to work on. [...] The 2003 policy plan mentioned that we aimed for 'Internet service' on the network. And it arrived. If there are volunteers who value this (still) very highly, they will do everything to maintain it and keep it working. Nothing wrong with that."

The board members thus tried to 'solve' the friction by enrolling the 2003 policy plan. Instead of deciding which value should be central in Wireless Leiden, the board members adopted a procedural strategy: decisions on how to order multiple values should emerge as part of ongoing work practices.

Indeed the Wireless Leiden community used to work with specific procedures for creating consensus taking decisions, based on the procedure 'consensus gauging through voting' , that has been developed in the open source Apache web server community (Apache Software Foundation, 2009). One of Wireless Leiden early volunteers Dirk-Willem van Gulik happened to be a previous board member of the Apache Software Foundation. When Van Gulik became involved with Wireless Leiden during its initiation, he brought with him his expertise on and experience with 'community management'. He advised the Wireless Leiden collective to make use of the 'Apache-way' of organizing volunteer-run open source technology projects. In this way Wireless Leiden community decided to adopt a distributed decision making procedure based on specific voting rules.[20] In Wireless Leiden everyone who has signed the Wireless Leiden volunteer agreement, is automatically granted access to the digital repository, and allowed to vote and commit on the volunteer list.[21]

[20] Based on his experience with the Apache project, in an e-mail to the volunteers Van Gulik reminds them how the system of distributed decision making works again: "Some on line groups solve this problem with a special type of proposals and voting procedures. As a reminder their system (which also more or less applies within Wireless Leiden): A proposal means:I submit this proposal -AND- I back it — AND — I will DO it as well. It is 'my problem'. A vote on a technical proposal means: +1 Yes I support it — AND — I back it; if something goes wrong I am the first to help solve it. +0 Good idea — I am supportive; but do not expect any more involvement. -0 Bad idea; but I will not stop you and I have no better ideas myself. -1 Veto: No — this is completely wrong -AND- in this mail itself of within a few hours at most I will back this up with technical arguments — AND — within 1 or 2 days I come up with a better plan that I completely back myself. If that plan gets accepted, and it still goes wrong, I am the first to solve it. A proposal needs at least 3 +1's. [...] The idea is that this way no one obstructs progress (even when it is not ideal) — while still striving towards consensus."

[21] In practice however, certainly not everyone has access to anything. For example the passwords for accessing the wireless nodes are a 'secret' shared by only a small subset of the (technical) volunteers. And there is no clear and transparent procedure or policy for who is admitted access to the knowledgeable 'in-crowd' (interview Tom den Duijf, 2008-07-01). A similar example consists of those volunteers carrying a key to the building of Wireless Leiden, or the locks of the cabinets containing hardware. Finally, the root password for the Wireless Leiden servers is only known by two people, the current and previous system administrators. This situation is rather fragile in case such persons would leave the Wireless Leiden collective either intentionally, or because of an accident (the so-called 'bus accident factor').

This particular system has proven itself in practice as a valuable tool for community management. It not only guarantees progress — proposals are accepted if at least three people vote in favor of it and commit themselves to execute the involved work — but also prevents obstruction, as votes against a specific proposal without any alternatives given cannot stop new initiatives that are supported and committed. The only way for a volunteer to stop an initiative is to come with an alternative proposal aligned with the promise to execute this proposal when accepted. The voting procedure above all is meant to create consensus and decisiveness in the community. For the board members this community decision making system proved to be a strong enough coordination tool to create even community consensus on the new, controversial commercial initiatives.

The strategy of creating consensus on the values was not only realized by using this community consensus decision tool. Values, and their ordering are continuously enacted through everyday interactions within the Wireless Leiden community. Discussions also serve to socialize and educate new volunteers in such a way they adapt to the local culture. For example when questions on creating consensus arise in the form of questions of new volunteers, other volunteers take on the role of educator by explaining how things are done. Another strategy articulated by a board member is what one could call organizing "consensus meetings".

> "[W]e fail collectively if we do not inform new people about such matters. Our volunteer group expands and sometimes people quit. That means that the current knot of volunteers no longer knows what was decided in the past, let alone why. And perhaps has completely different ideas now. I think it is beneficial to discuss these things anew once a year or so. To explain why we do things in specific ways and to gauge if this is still backed by the volunteers."

A volunteer responds favorably to this proposal by stating: "The previous discussion seemed more like a diktat ("The technology meeting has decided..."). I value an open mind. 'We' are Wireless Leiden, not 'they'."

To conclude, this friction on values and their ordering clearly shows the importance of creating consensus in a heterogeneous community, or on how to continue progress despite lack of consensus. The board members managed to mitigate frictions on the values and their ordering, by successfully referring to the communality values and using routines and practices that actually enhanced the community feeling.

Friction on steering volunteers

A second type of friction is evoked by a board member's attempt to decide what work volunteers should do. On the mailing list, the spark for discussion consisted of a volunteer member asking for help to solve a specific problem. This was the particular question:

> "Fellow volunteers, a bit of an unusual question: Has anyone of you ever tried to mount a camera to an advertising zeppelin and transmit the images to the ground? One of my colleagues at work has a nice idea for an opening of a drinking-water station. [...] Perhaps somebody could take care of this commercially? It will cost him money anyway."

In reply then, some volunteers mention pointers towards potentially useful people and similar projects. In addition, one volunteer offers practical help:

> "I offer to build something with you together, low-cost for education :-) Reimbursement of the costs and covering potential damage to devices (+ a bottle of wine :0)) would be all right with me."

The then-current chair of the Wireless Leiden foundation, Koolhaas, takes this thread as an opportunity for initiating a debate on commercial activities involving wireless technologies. In terms of coordination work, what is going on here is an attempt to actively "steer" volunteers away from unwanted towards useful behavior.

> 'Just to start a discussion: Because Wireless Leiden is the figurehead of wireless activities in the Netherlands we will receive an increasing number of this type of requests. Attractive projects! One of the aims of the foundation is to stimulate economic activities. If a commercial question arrives and we answer those from a hobby background, those start-up companies are nipped in the bud, which to me seems not conformable to our objective. [...] Another problem is that our technical people encounter a massive amount of fun jobs, while at the same time there are also plenty important jobs to do within Wireless Leiden."

Let's have a closer look at this specific posting. In the first place, the importance of the economic value of Wireless Leiden is stressed. In other words, its priority is high. The message implicitly refers to the "memorandum of association" of Foundation Wireless Leiden, which explicitly states that one of its aims are "stimulating and initiating economic activities in the domain of broad computer networks in general and wireless technologies in particular".[22] Because volunteers declare in their volunteer declaration that they adhere to these aims ("the volunteer subscribes to the aims as established in the articles of association of Foundation Wireless Leiden"[23]) Koolhaas can truly claim to represent all volunteers, and act as spokesperson of the collective, hence his individual use of the plural "we". In this message we can identify a reinforcement of the previous choice of the Wireless Leiden board to separate commercial activities outside Wireless Leiden from volunteer activities within Wireless Leiden. Also reinforced is the fact that volunteers should focus on the improvement of the Wireless Leiden net, and not become diverted by other "attractive projects", as

[22] Source: statuten Stichting Wireless Leiden, article 2, 1-c.
[23] Source: "Vrijwilligersverklaring-v04.pdf", version 4, 2004.

this can hamper the future development of Wireless Leiden, which in effect would hamper further commercial spin-off. In a sense, there appears an outline of an interesting hybrid entity, consisting of the non-profit Wireless Leiden combined with commercial activities around it. However, in order not to spoil the non-profit image of the brand name Wireless Leiden, commerce is effectively sorted out. This activity of sorting is done by the Wireless Leiden board.

However, as a reaction this attempt is met with volunteer resistance. For example, the volunteer who offered his help for almost free, articulates his irritation, based on a different view. Volunteers should be able to decide for themselves which tasks they work on, and which ones not.

> "[U]uuhh, commercial is an _option_, but hopefully no obligation? As in that case I would like to know if I can send an invoice for the development of the node factory. Count on twenty hours a week over the last six months. [...] As I stated before, doing things together, developing new things is what I think is fun/relevant. Making money is not my priority. Moreover, there are plenty of other places, which are actually much better for doing so :-) This is the volunteer list, and not the list with offers for commercial projects. [...] After Wireless Leiden decided what I _need_ to spend my time on (HCC project), now it also prescribes what I _not_ must spend my time on. Peculiar..."

By now, what started out on the volunteer list as separate threads on distinct topics, start to converge around the the single issue of commercial activities. This is also indicated by the subject headers of the posts, which become rewritten as "Commercial activities".

Nonetheless, this poster as well, does seem to agree with a strategy of sorting into distinct compartments. However, it is the overflowing between these spaces that is then perceived to be problematic. Commercial activities do not mix well with volunteer activities, and thus do not belong inside the domain of Wireless Leiden.

At that point in the discussion, the original poster makes his voice heard again, in order to explain his original intentions in order to tone down the debate. Although in his opening post he might have stated that "commercial" was an option, in the end, he explains he actually only meant it to be merely a "hobby thing".

> "It is not sure if it will be a large project at all. [...] The fact that a Zeppelin was involved, in addition to a big screen, just unleashed some wild associations in me (some kind of brain deformation I admit, albeit innocent). So I only threw out some ideas. [...] I just intend it to become a hobby thing together with Marten. As some old colleagues are involved as well, it will be really cozy and sociable. However, if the customer prefers a commercial trajectory, I will certainly report that on the list."

This quote again stresses the importance and relevance of the communality values in innovation communities. The sense of belonging to a community,

enjoying both the sociability as well as the technical challenges, is the essential glue of a volunteer community. However, this friction too shows the delicate balance between personal autonomy and community control. When money comes in through new commercial activities, this balance can easily be disturbed. The strategy of compartmentalization shows it limits in the actual emerging practice, as several volunteer | entrepreneurs are active in both the non-profit Wireless Leiden and the commercial Wireless Cluster. It is however, the communality values in Wireless Leiden that still have enough binding power. The vulnerable boundary between profit and non-profit in community innovation is even more pregnant at stake in the following friction.

Friction on rewarding work

The third topic on the volunteer mailing list developing into a discussion was initiated by a news announcement about a project under the name 'Soundnet' as described in section 5.3.2. The basic idea is to develop a distributed aircraft noise monitoring system, making use of Wireless Leiden for access to rooftops for placing sound measuring devices as well as using the network to transport the noise data to a central server. Soundnet itself is organized as a non-profit foundation, run by people with previous professional experience in the domain of computer networking. In the following post, Jasper announces the plans for active cooperation with Soundnet.

> Subject: Soundnet (20040924)
>
> Last Monday, together with Gerard, I had a meeting with Rene Post from Soundnet. [...] We have the following plan:
> 1. Soundnet, Wireless Leiden and the wireless cluster together put forward a plan to the municipalities of Leiden and/or Oegstgeest.
> 2. Wireless Leiden makes available its network for connectivity between the measuring stations and the iPing office. Wireless Leiden brings in its contacts with location owners and discusses installation of new equipment.
> 3. Soundnet supplies the measuring stations + 1 full year of reporting + service.
> 4. The cluster takes care of the installation.
> 5. All parties give publicity to their joint effort.

This message sketches a first outline of how a cooperation between Wireless Leiden, external actors and the "wireless cluster" could look like, and the different roles actors play. In this text, an image is created in which Wireless Leiden plays the role of providing the infrastructure and as non-profit interface with "location owners", companies in the wireless cluster are involved in the installation of new devices, so there is no dependence here on "volunteers" that could slow things down. Finally, the service of measuring aircraft noise itself is provided by the new "Soundnet foundation". However, the biggest problem is point four: the installation of the Soundnet equipment is proposed to be located

in the commercial cluster, implying that volunteer | entrepreneurs are getting paid for identical work volunteers do for free.

The board member first articulates the importance of having this public discussion:

> > In the past we agreed that outside Wireless leiden anybody is
> > free to create a profit, but not within Leiden. And that is
> > where in this this case is the cinch.
> If you are working on wifi networks or servies. Johan / Anywi is free to sell antennes to private persons in Leiden.

This quote shows how previous arrangements to deal with commerce in the Wireless Leiden commons, and what is considered acceptable, is continuously being refined. In the quote above the board member explains to a volunteer how under certain conditions commercial activities can be legitimate even within the confines of Wireless Leiden, in this case framed as the geographical boundaries of Leiden. Additionally, a refinement is made that commercial activities are only allowed if they do not involve Wi-Fi networking or Wi-Fi services, as that would directly compete with Wireless Leiden already offering a Wi-Fi infrastructure. However, selling single black-boxed hardware objects such as antennas or client solutions is fine, for they only strengthen the existing Wireless Leiden network by delegating connection work to non-humans, and the companies distributing these non-humans as intermediaries. Underlying this distinction is the issue of the ether as scarce resource, and geographically tied to Leiden. In this sense the Leiden Wi-Fi 'space' is a true commons, because interference poses a real problem; and additional Wi-Fi use not aligned with Wireless Leiden diminishes Wi-Fi ether resources available to them.[24] Meaning in practice that Wireless Leiden connections will become slower and less reliable, or eventually completely broken.

What makes this case so interesting, however, is the fact that although the 'ether' might be conceived as true 'commons' in the sense of a 'common pool resource', which means that if I take something you can no longer have it. Other elements of the community innovation are no real commons. This is true for the 'digital' elements of the system, in the form of software source code, or information about specific configurations and solutions. If I tell you what I know, I do not loose this knowledge myself, and can still use it. However, there is another element of scarcity involved, and that relates to the number of volunteers, their time and the amount of work they can do.

What we see here, can be described as coordination work of negotiating and defining the boundaries between non-profit and profit. Defining the core values and core tasks of the non-profit Wireless Leiden, and the arguing whether these are endangered form the core work to mitigate this friction on financial rewarding.

[24] The implications of conceiving Wireless Leiden as an 'ether commons' are not fully analyzed here; for a first exploration, see Verhaegh (2008c) (although written in Dutch). Ostrom (1990) is the 'standard' reference on the topic of 'governing the commons'. Yochai Benkler wrote extensively about wireless infrastructures, digital networks and the commons; for instance see Benkler (1998a,b, 2000a,b, 2001, 2002b, 2003a,b, 2006).

5.3.4 Decentered coordination work

In short, I sum up the main conclusions of the analysis of the value-conflict on commercialization in the Wireless Leiden collective.

First, in this value-conflict coordination work succeeded in overcoming the tensions that emerged once economic values were introduced within the Wireless Leiden collective.

Second, the style of coordination work can be characterized as *decentered*. Decentered in this case refers to multiple characteristics of coordination work that involve a multitude of locations, actors, and strategies.

Thirdly, overcoming the value-conflict on commercialization resulted in what I would call a horizontal value-arrangement, in which multiple values are ranked next to each other in stead of being stacked upon each other, implying a hierarchy.

Fourth, a horizontal value-arrangement as encountered in Wireless Leiden in the period during the first value-conflict could perhaps best be described as 'coherence-in-tension'.[25] It is thus important to note that in community-based innovation there will always be tensions, especially because this type of innovation process relies so much upon the simultaneous availability of differently valued technology practices. Hence coordination work is a necessary precondition for the stable functioning of community-based innovation.

To conclude, the value-conflict on commercialization did not result into a destabilization of the Wireless Leiden collective because of decentered coordination work resulting in a horizontal value-arrangement for dealing with a situation of coherence-in-tension in a sustainable manner. However, this outcome was not inevitably linked to processes of community-based innovation. Things might have been otherwise.[26] The next section presents an example of an alternative value-arrangement.

5.4 Coordinating the value-conflict on professionalization

About a year after the value-conflict on commercialization, another value-conflict took place in Wireless Leiden between 2006 and 2007. Again economic values formed the leitmotif. However, in contrast to the previous value-conflict which became framed in terms of *commercialization*, this one was framed in terms of *professionalization*. The contested issue was not *if* Wireless Leiden should professionalize or not, but rather *how*.

This was no new issue, as in December 2003 Jasper Koolhaas, the then-current chair of the Wireless Leiden foundation, had already brought it up. However, by 2006 the issue had become more pressing. Wi-Fi had woven itself into the material fabric of everyday life globally, and Leiden was no exception. As a result of the established success of both Wi-Fi globally, and Wireless Leiden

[25] See Mol (2002, 84).
[26] See Bijker and Law (1992, 3).

locally, a new type of powerful actors had become interested in enrolling the Wireless Leiden collective into their own global networks. Therefore the issue had grown more pressing. Examples of actors expressing their interests were the Leiden municipality, local research and education institutes (Leiden University, Cetim, and Hogeschool Leiden) and local businesses. However, all these actors shared the characteristic that they were professional organizations, run by paid professionals. In response to this new development of external actors attempting to enroll Wireless Leiden as node within their own networks (in contrast to Wireless Leiden connecting itself as on top of already existing local infrastructures as a substrate), two different visions on professionalization were developed. The main difference between these visions rest on how to value the economic values of technology practices of community innovation: as primary value or not? Additionally, both visions favored different styles of coordination work. As a result of this trajectory of developing competing scenarios in parallel, tensions began building up. The proponents of both camps were so strongly attached to their own points of view, that this time the value-conflict resulted in fragmentation. Some board-members as well as a group of volunteers resigned. As a result the identity of the remaining fractured Wireless Leiden collective changed significantly. Before drawing any further conclusions about what we can learn about this value-conflict, first let us have a closer look first at how it developed, and then how it was quenched, effecting Wireless Leiden dramatically.

5.4.1 Trajectory 1: A professional innovation cluster

At the source of the previous value-conflict on commercialization were the emerging interests in the economic values of Wireless Leiden. However, the economic interests and activities were mainly emerging from *internal* actors who were actively involved as volunteers in Wireless Leiden. As we have seen, tensions arose only when actors attempted to engage economic activities *within* the Wireless Leiden collective. Commerce apart from Wireless Leiden formed no problem whatever for whomever. However, the permeability of the boundaries of the Wireless Leiden collective (both the organization as well as its technologies), enabled knowledge, people as well as artifacts to flow from the local network into the global network in order to engage in economic activities in other spheres, legitimately according to the social norms that had emerged within the Wireless Leiden community.[27] And a reciprocal flow, as commercialized and 'productized' hardware artifacts sold by different Wireless Leiden volunteers, who where simultaneously commercial Wi-Fi entrepreneurs, crossed boundaries to reappear into Wireless Leiden again after their detour through the markets (for example robust antennas cheaply produced in China). Key to understanding that such flows were possible, is that they were not threatening the identity of the Wireless Leiden collective. In fact, sometimes these flows were strengthening the Wireless Leiden collective even further.

[27] Especially the notion of 'Trojan door' introduced by Star (1992) resonates strongly with happened here.

However, things were quite different in the value-conflict on professionalization. By now, *external* actors had started articulating their interests in the economic values of Wireless Leiden, more specifically as infrastructure for exploring, testing and developing new commercial services and products. This time, it was not the Wireless Leiden collective folding global networks as collapsed nodes into its own local network. Quite the opposite, external actors started developing strategies for folding Wireless Leiden as a node into their own network. And their primary motive for including Wireless Leiden as node was to strengthen their own network rather than the Wireless Leiden network.

To give an illustration of how these actors aligned their visions, let us look in detail at a meeting in August 2004, when all actors were present during a special meeting organized around a working visit of member of Parliament Martijn van Dam and his staff member (both members of the Dutch socialist party PVDA). According to the minutes of the meeting, both visitors expected "to get information about the wireless technology". Although this suggests that the focus was primarily on the technology itself, the opposite was true, with a focus on the business side of Wireless Leiden. The minutes of the meeting, including summaries of the presentations, provide a clear example of the economic framing of Wireless Leiden.[28]

Huub Schuurmans, in his role as Wireless Leiden volunteer and board members, informs the both politicians in his "introduction to Wireless Leiden" that "[f]urther to the immediately visible function of providing a wireless computer network, there is another function: Platform for innovation. Already 6 start-ups have been founded by the group of Wireless Leiden." Additionally, Schuurmans emphasizes the creation of "jobs for Wireless Leiden volunteers" and the future development of a "wireless cluster". Next is the presentation by Bernhard Katzy, in his role as innovation expert at the University of Leiden and research institute CeTIM, who "gives an interpretation of Wireless Leiden as an innovation cluster", and explains how "companies profit from the reputation and the marketing of the network on a worldwide scale". Finally, in the third talk Henk Uittenbogaard, in his rol as chair of Foundation Wireless Jacobswoude and entrepreneur himself, "gives a presentation about the chances for the economy", and emphasizes how "companies can use Wireless Leiden for marketing purposes because the initiative gets more attention than a young starting company would get", and the "market needs". At the meeting Maarten van der Plas represents the views of the Municipality of Leiden on "regional innovative knowledge clusters". Interestingly, one of the Wireless Leiden nodes presents itself as well, as a visit to Node IMI located on the roof of the Municipal Archives, the building where the meeting is organized. After a lunch sponsored by the Municipality of Leiden, the meeting ends with a discussion that points to the facts that "[a]s an initiative of volunteers Wireless Leiden now needs professional help to survive[,] and exploit the existing network"; that "Wireless Leiden can be a platform for experiments" and finally that "[c]lusters are a

[28] Source: "minutes_mtng_with_M_van_Dam.pdf" online available on the Wireless Leiden svn repository. An additional information are the original Powerpoint slides, available in the Wireless Leiden repository.

platform for innovation because many people with different perspectives meet and discuss and thus generate ideas".

What matters most is that this meeting exemplifies how the interests of various actors, not only internally involved as volunteers but actors located external in relation to the Wireless Leiden collective as well, started to coalesce around the interest of 'bootstrapping' economic values off of Wireless Leiden, by creating connections between new actors, out of which networks such as a local "innovation cluster" or an "in-field laboratory" could emerge. However, a necessary precondition for such a trajectory of "exploitation" of Wireless Leiden, is a stable and reliable wireless infrastructure, which in turn requires professionalizing its operation, surveillance, maintenance, and administration.

The term professionalization of Wireless Leiden in this context means that the network is maintained according to "professional" standards, as companies are accustomed to when they make use of commercial infrastructures. This then means that maintenance and repair work (but also installation of hardware for new nodes) might be delegated to paid personnel, or in other words, professionals.

Most importantly, the interest of external actors in the economic values of Wireless Leiden did not appear suddenly. It was part of the trajectory predating the value-conflict on professionalization. To get a clearer view on the issue of professionalization, I first present a short overview of how some external actors developed an active interest into Wireless Leiden as node within networks they initiated themselves. In the years before 2006, the seeds of exploitation of the economic values of Wireless Leiden blossomed of into three separate but related trunks, connected by the involvement of Wireless Leiden as a node in global networks: Wireless Leiden as element of a "creative city", as member of a consortium for "regional innovation", and as infrastructure for a "living lab".

Wireless Leiden as node in a "Creative City"

The first example of how external actors became interested to weave Wireless Leiden into their own web is the Municipality of Leiden and their vision of Leiden as "Creative City". This idea was inspired by a workshop lead by economist Richard Florida. In this meeting Florida explained that the "creative class" was highly important for the economic development of cities Florida (2002). So after this workshop, regional Leiden policy makers suddenly were confronted with a new entity, 'creative class', which they had to take into account in formulating their policy plans. However, this concept started effecting Leiden policy plans, because of the publication of a report on the statistics of the creative class in Dutch cities (Marlet and van Woerkens, 2004). This report stated that "the presence of a creative class in a city is highly important for the local economy" (p. 5). This statistical exercise suddenly put the Leiden municipality in comparison with the rest of the Netherlands on its ranking lists first in percentage of scientifically educated people of the Leiden population (p. 227) and second in percentage creative class as part of the Leiden labor force (pp. 14 and 229). These initially surprising results motivated the Municipality

of Leiden, headed by the Department of Economic Affairs, further to re-arrange its policy plans around the notion of "creative class" for stimulating the further economic growth of the Leiden region.[29] Policy plans were developed to explore how Leiden could create a profile of itself as a "creative city", rooted in the belief of a strong correlation between a relatively large creative class and economic growth.[30]

In the light of the creative class as policy instrument for stimulating local economic growth, the Municipality of Leiden developed an active interest in the "Wireless Leiden" initiative, its wireless infrastructure and its image of success and innovation, as such an image was reported by the local, regional and national press. After an initial exploratory research trajectory, in which the Leiden based "research based consultancy" firm Blaauwberg played an important role,[31] the Municipality of Leiden defined 'Wireless Leiden' as one of the four major themes for increasing economic development in the city Leiden. In this way a strong connection was developed between Wireless Leiden as element in a policy plan for developing "Leiden as creative city".[32] It is striking that these reports mention the theme of a "wireless Leiden" as city, of which "Wireless Leiden" the volunteer initiative was only one out of many other elements. Apart from the Department of Economic Affairs of the Leiden municipality, other professional actors, such as the commercial company AnyWi, a Wireless Leiden spin-off company headed and represented by Henk Uittenbogaard, also become actively involved in initiating the effort of a "wireless Leiden". It is important to note that Wireless Leiden volunteer Huub Schuurmans, also actively engaged in this effort of connecting Wireless Leiden with the Municipality of Leiden.

Wireless Leiden as node in a "Regional Innovation program"

A second example of how external actors become more interested in Wireless Leiden is how Wireless Leiden becomes part of a program to stimulate research and education institutions to share their knowledge with local business. This effort was lead by the "Hogeschool Leiden". This organization initiated a plan entitled "Free Discovery", which consisted of forming a local 'consortium' to apply for state-granted subsidy. After an initial rejection of the project proposal in September 2005, a reworked application was carefully crafted with help of a "subsidy-application-specialist". In March 2006 the Free Discovery program was awarded approximately 300.000 euros by the Dutch Ministry of Education, Culture and Science[33] under the terms of their so-called RAAK program, which is an acronym for "Regional Attention and Action for Knowledge

[29] Source: Maters (2008).

[30] Interestingly enough, many documents note that most "creative people" living in Leiden are actually living in other cities within the wider Randstad area, including cities such as The Hague, Utrecht and Amsterdam.

[31] Source: Blaauwberg (2005). Talentenstad Leiden, Discussienotitie Stadsconferentie Kennisecономie, online available.

[32] Other relevant sources are Gemeente Leiden (2006) en Gemeente Leiden (2010, 7)

[33] The Dutch name is Ministerie of Onderwijs, Cultuur en Wetenschappen.

circulation".[34] The daily operations and allocation of financial resources of this program was delegated to the Foundation Innovation Alliance ("Stichting Innovatie Alliantie"), established in November 2003 and stationed in The Hague, residence of the Dutch national government. The mission statement of the RAAK program is defined as "facilitating circulation of knowledge between regional actors, such as higher education, small and medium enterprises (SMEs) and public institutes" in order to "significantly increase the innovative capacity of SMEs".[35]

In the introduction of the Free Discovery application, the relations between the different members of the consortium, including Foundation Wireless Leiden, are clearly defined, framed within the terms of the RAAK program.

> "Wireless Leiden and the techno-starters came to realize that the unique potential is not fully *exploited*. The companies therefore made an appeal to the Hogeschool Leiden to join forces in order to stimulate *economic* activity, research and development around the wireless network."[36] (Italics by SV)

Under the heading "participating organizations and their interests" (p. 8) three familiar names stand out, as part of the seven members of the "steering committee".

In the first place, the Wireless Leiden foundation, which "directly represents the interests of the techno-starters". The framing of Foundation Wireless Leiden in this document as a collective of technologically focused start-up companies is highly significant. Whereas in the previous controversy a dominant strategy for coordination work consisted of setting up a different space for commercial activities in the form of the commercial entity "wireless delta cluster", clearly separated from the non-commercial entity "foundation Wireless Leiden", this coordination strategy is no longer adhered to in this context. Instead, the non-profit Foundation Wireless Leiden is reframed as representing the interests of commercial actors. Listed as "contact to SIA as representative for the regional SMEs" is Huub Schuurmans, in his role as board member of the Wireless Leiden foundation.

Secondly, AnyWi B.V. is mentioned as consortium member in the form of an individual company, with Henk Uittenbogaard, listed as contact.[37] AnyWi is described as "[s]uccessful techno-starter that gladly dedicates its knowledge and experience in developing innovations centered around the wireless network".[38] However, its individual interests for participation in the program, as the heading

[34] Source: website SIA-RAAK, on line available http://www.innovatie-alliantie.nl/?id=503&t=RAAK_PBank. The official operational period of the (first) Free Discovery program was 2006-05-01 until 2007-04-30.

[35] Source: Website SIA, http://www.innovatie-alliantie.nl.

[36] Source: subsidie-aanvraag-Free-Discovery-mrt-2006.pdf page 4, on line available in Wireless Leiden repository.

[37] At this moment in time Henk Uittenbogaard chaired the Wireless Jacobswoude foundation, a Wi-Fi community network modeled after Wireless Leiden. Only later in time, in September 2006, would Uittenbogaard become involved in Wireless Leiden as official volunteer and as new chair of the Wireless Leiden board.

[38] Ibid, p. 8.

above indicated to reveal, remain unmentioned, apart from a generous sharing of their knowledge and expertise with other members. Interestingly, on a separate page (referred to as "see framed box") AnyWi is explicitly put in the spotlights as "a successful spin-off", in addition to already being represented by the Wireless Leiden foundation as member of the group of techno-starters. In a sense, this particular design of the document contributes to implicitly creating an image of AnyWi as a "primus inter pares" within the Wireless Leiden spin-offs. It is also the only company that is individually represented within the "steering committee" and individually enlisted within the financial budget.

Thirdly, CeTIM (Centre for Technology and Innovation Management) is mentioned, represented by contact Bernhard Katzy in his role as director of the academic institute, located in Leiden and Munich, Germany. CeTIM is described as "doing research on technology management, innovation and strategic change". The description continues to explain its involvement: "In the role of *external* coach CeTIM guides the evolution process of the wireless cluster in Leiden from the start."[39]

Wireless Leiden as node in a "Living Lab"

A third example of how external actors tried to enroll Wireless Leiden in their own network is how Wireless Leiden became involved as node in a "living lab". In the beginning of 2006 a program is launched to develop a "Living Lab" in Leiden with a central focus on "location-based services". This effort is partly an outcome of the project of stimulating economic growth in Leiden by focusing on the development of Leiden as 'creative city', and partly a result of earlier work of innovation management scholar Bernhard Katzy and his research on "living labs" in a European context. In April 2006 a concrete proposal was published.[40] This short document outlined the possibilities for a Living Lab for developing Location Based Services, located in Leiden. Its main aim was stated as to "stimulate and facilitate open innovation", by "bring[ing] together technical resources like university and company labs with advanced users, researchers, developers, marketers and venture capitalists in a breeding environment for open innovation" (p. 3).[41] However, the authors warn that "open innovation" does not work automatically, this requires coordination work, or in their own words "active effort and methodological skills to facilitate collaboration of people with different capabilities and backgrounds inside the cluster – and marketing and communication effort towards global partners and other regions and clusters" (p. 3). Hence they add: "[f]acilitation of open innovation is

[39] Ibid, p. 8.

[40] Source: Bernhard Katzy and Wouter Mensink (2006). "The Living Lab Location-Based Services Leiden in Holland-Rijnland". Leiden: Cetim. On line available at http://www.livinglab.nl. The document itself explicitly refers to ideas developed at 31 March 2006 "Creative workshops" organized by the Municipality of Leiden for their "creative city" project.

[41] The notion of open innovation was introduced by the American scholar Henry Chesbrough (2003). It is important to note that although both "open innovation" and "community innovation" might be understood as forms of distributed innovation, they involve a completely different ordering of values of technology practices involved. Open innovation is explicitly framed within economic values for "profiting from technology", to quote Chesbrough from the title of his book.

needed. The simple fact that there are people with a shared interest in a region does not imply that collaboration will develop spontaneously". (p. 4) The potential yield framed in terms of economic values is high: "The number of jobs that could be created is at least three times the amount of an average European region" (p. 8). The technological infrastructure for the location-based services for the Living Lab consists of a combination of two parts: the Wireless Leiden Wi-Fi network on the one hand, and on the other hand the Galileo positioning satellite system – an ambitious European Union project to create an equivalent of the United States owned and operated Global Positioning System.

Economic values as core element

In all three examples above we saw how the interest of external actors to incorporate Wireless Leiden in their own plans was exclusively shaped by economic values. The main aim in all three examples was stimulating economic growth with innovation as the motor behind it.

The main protagonists are no longer a diverse range of actors spanning entities such as residential users, technological devices, open source software, forces of nature such as wind, rain or invisible electromagnetic waves. Instead the main actors within the examples are all "professional associations", such as small and medium sized enterprises (SMEs), research institutions functioning as intermediaries for facilitating "knowledge circulation", and "regional innovation", governmental organizations located at the local, provincial or national 'level'.[42] What is interesting to see here is the change from the focus of the activity of 'networking'. Instead of a focus on the end-result of the activity of networking in the form of a wireless communicative assemblages, Wireless Leiden becomes part of an effort in which the activity of 'networking' emerges almost as a goal in itself, probably rooted in notions of "open innovation" in which economic growth is a result from creating strategic alliances between various commercial corporations. A sort of Wireless Leiden as a "network inside out",[43] with a focus on actors engaged in "networking" as social activity instead of the goal of creating a material infrastructure for wireless communication.

Most importantly, in this trajectory of developing a professional innovation cluster, the vision on how to professionalize Wireless Leiden was developed jointly by actors internally involved in the Wireless Leiden collective as volunteers or board members on the one hand, and external actors not actively involved in the Wireless Leiden collective on the other hand. The projects described above illustrate this development by the active involvement of a small group of "flagship captains", consisting of persons such as of Bernhard Katzy, Huub Schuurmans, Henk Uittenbogaard and the representative of the Leiden Deputy of Economic Affairs. The connecting thread through the three examples of "exploiting the economic potential of the wireless network" is formed

[42] I deliberately place the term level between brackets in order to make explicit that such notions are not a priori ontological categories, but enacted in practices, as results emerging from everyday interactions between practitioners of different kinds.

[43] For the notion of "the network inside out" see Riles (2000).

by this core group of actors mentioned. In other strands of literature such actors referred as 'institutional entrepreneurs'.[44] What sets these institutional entrepreneurs apart is their shared expertise in skillfully creating strategies for coordination work that are primarily outwards focused.

The three developments described above, together resulted in a situation in which external actors became increasingly successful in weaving Wireless Leiden as nodes into their own networks. In terms of multiple values of technology practice involved, it is clear that all the interests of external actors, professional organizations, were explicitly aimed at exploitation of the economic values, or perhaps rather value, of Wireless Leiden. This raises the question of how to coordinate the internal valuing of technology practices within Wireless Leiden, with the external valuing of Wireless Leiden outside of it. What strategies for coordination work were developed to overcome increasing tensions between actors with different views on valuing Wireless Leiden?

5.4.2 Trajectory 2: A professional community innovation

Partly as a response to the developments of transforming Wireless Leiden into one of the elements of a professional innovation cluster, and partly as a further continuation of the everyday technology practices of Wireless Leiden volunteers, board members of the Wireless Leiden foundation developed a plan for Wireless Leiden as a professional community innovation. The Wireless Leiden volunteers were the key focus, and their values were central in this trajectory. In a sense this trajectory was a further continuation of how Wireless Leiden was initiated as described in chapter 2 (Alignment work). In order to illustrate this point I shortly describe how in this trajectory primarily non-economic values of community innovation technology practices were considered of key importance.

In February 2006, a group of freshly appointed foundation board members, headed by the new chair Ger Koper, articulated their vision of the further development of Wireless Leiden in a "plan of action". This document, actually a kind of collective 'to-do' list, articulated the agenda and the key priorities of Wireless Leiden for that year.[45] In this document the board members proposed to the other volunteers the course to be taken by the Wireless Leiden collective in the coming period. The document describes the focus of Wireless Leiden as:

> "Wireless Leiden aims to become the leading wireless broadband network globally! With leading we mean the following:
> - Technologically: the most advanced technology
> - Knowledge dissemination: educating our own volunteers, students, etc
> - Use: demonstrating the most fantastic possibilities!"

Relevant here with regard to values of technology-practices, is that the definition of "leading" spans multiple dimensions, including different values of technology

[44] For an introduction to the notion of institutional entrepreneur, see Garud et al. (2007).
[45] Source: 2006-02-13 WL-DATA-DOC "Concept actieplan"; on line available in the Wireless Leiden repository.

practices. In this vision-document, the Wireless Leiden board explicitly acknowledges the importance of attending to different types of technology-practices for the further development of the network. Let me offer a short overview of how values of community innovation practices can be distinguished by further analyzing how this document articulates a specific view on professionalization. All subsequent quotes are taken from the same document source.

In the first place, the text articulates how *virtuosity values* are related to the technologies of the wireless infrastructure. This includes an update to the backbone of the Wi-Fi equipment, involving a replacement of 802.11b equipment with the more reliable 802.11a version, which is supposed to be less susceptible for interference by residential Wi-Fi access points. The text also mentioned "creating a modern, professional, internationally accessible website", "developing towards a maintenance free network" as result of standardization and "automatic configuration" of node software. All these activities are examples of activities whose values relate to mastering technological challenges.

Secondly, *communality values* are explicitly addressed as well. The text of the vision document mentions that coordinating the volunteer community is a responsibility of the board members. In practice this coordination work includes various activities. First there is "reinforcing solidarity" by organizing frequent and publicly accessible volunteer meetings. Then there is "professionalizing the volunteer organization" by creating explicit descriptions of volunteer's roles, responsibilities and formalizing relations between volunteers and the board by introducing written agreements. Another activity is "educating volunteers" by organizing courses which differentiate between different types of volunteers and their related skill sets and knowledge levels and by "organizing a conference" on wireless matters. Finally the text mentions "recruiting new volunteers".

Thirdly, *user and need values* are articulated under the heading of "network use". Two different types of uses are identified: (a) professional use needs such as "streaming video broadcasting" such as local church services, or sport events, and "cooperating with companies and educational organizations for developing new services"; (b) home use needs "Internet for the financially weak" and "supporting users" in the form of walk in consultancy hours, open meetings and attending local IT-related events.

Fourth, *economic values* are articulated implicitly nested under user and need values. Upon closer inspection, they are only mentioned as "developing new services". Therefore it is especially striking that although economic values are only briefly mentioned, the Wireless Leiden board accompanies these words with an explicit caveat regarding commerce:

> "Fundamental agreement: a network of volunteers, no interference from commerce in network development except for open source agreements conforming to the Wireless Leiden license."

To conclude, for the year 2006 the Wireless Leiden board articulated a vision of professionalization, framing Wireless Leiden primarily as a professional community innovation. Coordination work explicitly involves overlooking *all* four values of community innovation practices. However, in this values-

arrangement virtuosity and communality values are clearly prioritized over user or need values, and economic values are mentioned lastly and only briefly. In terms of coordination work, responsibilities of the Wireless Leiden board are mainly aimed at maintaining and reinforcing internal connections between actors already part of the hybrid collective Wireless Leiden. The main volunteers and the wireless technologies are valued as the most important "capital" of the collective. Professionalization therefore should be focused on how the Wireless Leiden organization and its volunteers can strengthen each other. For example by devoting attention to actively interesting new volunteers into the collective, offering volunteers courses in order to act in "professional" ways, and finally managing the organization more professionally. This vision is further exemplified by the fact that slides of volunteer meetings repeatedly state that "things should be fun for the volunteers"[46]. Regarding communality values it is important to note that in the same year, the board initiated the organization of a so-called "wireless community camp", aiming at facilitating "wireless communities" and activities of "doing-wireless-together".

The first Wireless Community Camp took place in August 2006. As an attempt to connect different communities with an interest in "wireless", the wireless camp successfully brought together people from different cities, countries and even continents, with different types of relations to wireless technologies: users, hackers, radio amateurs, researchers on wireless communities, and even the previous chair of the IEEE standardization committee on 802.11, Vic Hayes, actively participated in the event. Also, the camp succeeded in bringing together in space and time specific "wireless community" events that previously took place unconnected. For the first time in the Netherlands a single event offered the unique combination of a "war-sailing" boat trip, an "antenna measuring contest",[47] and various "doings-things-together" workshops such as building different types of outdoor Wi-Fi antennas.[48] In short, the coordination work within this professionalization trajectory was primarily aimed at strengthening connections between actors valuing virtuosity and communality values of enacting community Wi-Fi.[49]

Most importantly, in this vision external actors only selectively interested in the economic values of Wireless Leiden, are considered as a threat rather than an opportunity for the stability of the local Wireless Leiden collective. To wrap

[46] Source: WL-DATA-DOC-20060303-PPT-vrijwilligersbijeenkomst

[47] Previously part of the yearly "Wireless open air festival" hosted by http://www.wirelessnederland.nl.

[48] Taking place at workshops and "Birds of a Feather Session" (BoFS) during hacking events such as "What the Hack" in 2005 or the yearly hackers congress organized by the Chaos Computer Club in Berlin

[49] See Coleman (2010) on how hacking conferences demonstrate "how social enchantment and moral solidarity, often thought to play only a marginal role in the march of secular and liberal modernity, is in fact central to its unfolding." (p. 47). In her (unfortunately unpublished) PhD thesis Coleman (2005) offers a detailed analysis of the central motifs of value for hacking as enacted in everyday practices marked by a repertoire of micro-practices, mainly favoring a virtuous display of technical abilities and intelligence.

Also see: "Codes of value: an anthropological analysis of hacker values" presented 2006-05-20 at DebConf 6 by Gabrielle Coleman. Audiovisual recording on line available: http://meetings-archive.debian.net/pub/debian-meetings/2006/debconf6/.

up: key to understanding this particular view on professionalization is that strengthening the local network of the Wireless Leiden collective is based on prioritizing non-economic values. External actors only fit in the Wireless Leiden actor-world if they are translated into internal nodes. Additionaly, economic values of external actors should be translated as well into, and certainly be not detrimental to, virtuosity, communality and user or need values of the local network.

However, while developing this view on professionalization, the board members of Wireless Leiden did not acknowledge the rising involvement of external actors which became increasingly involved in deciding on the future course of Wireless Leiden. As the Wireless Leiden collective became more important for the development of external actors, these external actors also become increasingly involved in steering its further development. The then-current board members were mainly focused on virtuosity values and communality values, and much less interested in, or even hostile towards, the increasing interests in economic values of Wireless Leiden.

5.4.3 Fracture and fragmentation

In September 2006 tensions built up to a maximum between people involved in developing Wireless Leiden along divergent trajectories for professionalization of Wireless Leiden.

On the one hand, in the trajectory of developing a professional innovation cluster, people such as Huub Schuurmans and Henk Uittenbogaard had been proactively involved in the previous months in attempts to coordinate the initiation of new networks in which economic values of innovation formed the core aim. In these networks Wireless Leiden was only one of the many elements in addition to others such as private companies, educational institutions, intermediary organizations involved in facilitating innovation or carrying out subsidy schemes, and various government agencies responsible for local, regional, national and European policy making. For coordinating this activity of "external networking" Schuurmans and Uittenbogaard gained recognition and credit within the wider community of people involved in 'the wireless business' in the Leiden region, based on their successful attempts at including themselves on the agenda of the local government, bringing in subsidies, and setting up programs such as Free Discovery based on connecting Wireless Leiden with external actors, all connected by an interest in the economic values of Wi-Fi innovations.

On the other hand, in the trajectory of developing a professional community innovation, people such as Marten Vijn — one of the initiators of Wireless Leiden, elected as new chair of the board only a few months ago — together with Gerard Mourits had been involved primarily in focusing on communality values and virtuosity values.

Over time the two trajectories had diverged increasingly. As a result the tension within the Wireless Leiden collective had also built up accordingly, as the collective was pulled into opposing directions. Eventually, this situation resulted in a fracture in the Wireless Leiden collective. This fracture started

during a meeting of the Wireless Leiden board in September 2009, where board members were to decide on the further course for the professionalization of Wireless Leiden. Attending as guests were Henk Schuurmans and Henk Uittenbogaard to present their plans for professionalization which involved hiring Bureau Blaauwberg, the same Leiden consultancy agency which had lead the "Leiden as creative city" commissioned and paid for by the municipality of Leiden. In the same manner, the municipality of Leiden had agreed to pay the consultancy costs. The idea behind this plan was that Wireless Leiden as part of a professional innovation cluster would generate economic growth within the Leiden region. This plan was called "trajectory Blaauwberg". However, other board members perceived such a project as a commercial "sell-out". More importantly, it was suggested that such a project would decrease the virtuosity and communality values of Wireless Leiden for its volunteers. Although a long debate took place that evening, no consensus could be reached in the end. Only the next day, after some turbulent changes in the composition of the board, involving old members to resign, and new members to enter, the newly appointed board unanimously commenced consultancy agency Blaauwberg to initiate their research into the best trajectory for professionalizing Wireless Leiden. Under the precaution that the municipality of Leiden would provide the financial resources for paying the costs of hiring Blaauwberg.

The morning after the discussion that took place amongst members of the board and advisory body, some individuals involved in the debate started informing the non-board-member volunteers about the events that until then had mainly taken place 'back stage' as the board meetings were closed, and not accessible to other Wireless Leiden volunteers. Gerard Mourits, who had attended the dramatic board meeting as member of the advisory committee to the board, summarized the issue in a open mail. His message was in the first place directed to chair of the board, Ger Koper, who had been absent during the crucial meeting. His fifth vote could tip the scale between either developing Wireless Leiden by "extending Wireless Leiden as it is; bringing it technologically to a higher and acceptable plan" or "developing Wireless Leiden into a commercial platform".[50] "As the votes are equally devided 2/2, we thus choose to lay down the question to you as fifth board member." Mourits then continued: "The fact that such a situation could develop alone, made it easy for me to decide to leave Wireless Leiden." He then concluded that "Commerce and Wireless Leiden in my view don't go together". In order to stress his multiple roles of involvement, Mourits signs off his message as "volunteer Wireless Leiden, chair advisory body, chair Wireless Rijnwoude".

The second person resigning from Wireless Leiden is Marten Vijn, who also sends a message to the volunteer list in which he motives why he resigned as board member:

> "Personally I regret the recent developments of Wireless Leiden. I do not see any possibilities to bridge the current differences in vision. Given yesterday's vote I no longer wish to be a member of the board,

[50] Source: email Gerard Mourits 2006-09-09 on Wireless Leiden volunteer list.

nor be active as a volunteer."[51]

Finally, Ger Koper was the third person stepping back from the stage.[52] However, his motivation differed as he stated that "due to serious personal circumstances I have to end my board membership prematurely". Koper then continued to explain his vote of support for the Blaauwberg trajectory:

> "For the continuity and success of the volunteer organization I think that extending the board with experienced administrators like Henk Uittenbogaard and Huub Schuurmans is of uttermost importance. [...] Their involvement will lead to a solid organization with a sound financial foundation and a larger esteem in the region and beyond. In short, a volunteer organization for which it is a challenge to do fun things."

Two days later Rudi van Drunen, another board member who had attended the crucial meeting, sent "a message to the volunteers" offering "a short summary of the situation".[53] In his mail Van Drunen presented an overview of the topics discussed during the meeting: a vision for the future, how to develop such vision in practice, keeping the option open for hiring paid professionals if no volunteers workers were available, and separating policy making by the board from implementation by volunteers. Van Drunen also explained how this discussion had lead to a change of board members with Vijn and Mourits stepping out, and Schuurmans and Uittenbogaard stepping in. In response to the earlier mails criticizing the decision on prioritizing economic values, Van Drunen reassured that "[t]here was no mentioning of a 'commercial platform' or on 'going into commerce'". Finally, Van Drunen then mentioned that the board had decided to hire the consultancy firm Blaauwberg to guide the professionalization process.

Interestingly, on the volunteer list these mails did not evoke a lot of volunteer response. Only a few volunteers posted short messages. One person stated that he found it irresponsible for a chair to resign already within a month. Another person explained that "this is not about adding new board members but about the commercial-versus-open discussion". A few other volunteers finally congratulated the new board members with their roles, and wished them lots of luck and wisdom, "as they will probably need it".

This rather low number of e-mail responses stands in great contrast with the value-conflict on commercial activities that generated large amounts of traffic on the volunteer mailing list. As the second value-conflict is about how to deal with external actors in the form of companies and organizations as "users of the network" in relation to Wireless Leiden, presumably this issue is not directly interesting for volunteers mainly interested in virtuosity values of technology practices. Most of them regard the issue of how to deal with external actors, or applying for subsidies as part of "politics", an actively best left to board members.

[51] Source: 2006-09-06 email Marten Vijn on volunteer list.
[52] Source: 2006-09-09 email Ger Koper.
[53] Source: email Rudi van Drunen, 2006-09-11.

After the fracture within the Wireless Leiden collective, fragmentation occurred. Where before technology practices on wireless had been focused within the Wireless Leiden collective, the fragments of the collective now became scattered over the larger Leiden region, divided along lines of interest or disinterest in its economic values. One part of the collective continued its further development under the name Wireless Leiden. Although the name Wireless Leiden had remained the same before and after the fracture, the collective was now moving into a new direction, engaging on a journey exploring economic growth. This "trajectory Blaauwberg", will be discussed in further detail in the next section, when we have a closer look at the process and how it materialized into the organization of Wireless Leiden.

The other part which fractured off of Wireless Leiden, consisted mainly of volunteers who were primarily interested in virtuosity and communality values. Whereas such situations of fracture within literature on free / open source software communities are usually framed in terms of forking, this is not an apt description for the situation in which the ex-Wireless Leiden volunteers had maneuvered themselves into.[54] The moment they resigned from Wireless Leiden as volunteers, they also lost access to the physical wireless infrastructure. If these people wanted to continue their wireless technology practices beyond tinkering at their own homes, they needed to build something new. And that is what they did. Marten Vijn and Gerard Mourits started an alternative doing-wireless-together initiative for which they set up a new non-profit volunteer foundation named 'Wifi-soft'. Together with other ex-Wireless Leiden volunteers they continued to explore wireless-related technologies. However, deprived from access to Wireless Leiden as stage for enacting technologies as identity-projects, they created new stages. Wifi-soft continued to organize a yearly "open community camp". Also, monthly hacking meetings were organized, usually at one of the homes of the participants. Also they explored technological alternatives for Wi-Fi, for example optical wireless, as developed in an open source manner by the Ronja initiative in Prague.[55] What these ex-volunteers had lost, was their access to the technological niceties that resulted from the large scale the Wireless Leiden infrastructure had grown into it over time. However, they had also won something, the freedom to explore and experiment with technologies, without the need take care that the network as a whole kept working and other actors (such as home users or organizational sponsor-users) could not become unconnected.

In a sense it is ironic that one of the outcomes of the effort to strengthen the

[54] This is a major difference from fractures in open source software projects, where if participants decide to start another alternative project, they are usually free to take all the source code with them, and start an alternative project under another name. For an examples of a description of the process of forking, see van Wendel de Joode (2005, 115-116). Kevin Crowston made a similar observation in his presentation entitled "What Wireless Community Networks can learn from the Open Source Community". Crowston presented this talk in 2003 after studying Wireless Leiden. In his talk Crowston observed that in cases of wireless networks the "project is harder to fork" compared to open source projects, as the former "project resources include physical goods that have to be paid for and supported". Source: 20030625-WL-DATA-PPT-KevinCrowston, available on line.

[55] For a Science and Technology Studies perspective on Ronja, see the case-study by Söderberg (Forthcoming).

Wireless Leiden collective by interesting external actors in it, actually resulted in a weakening of its internal network because of the loss of technical volunteers. As a consequence of this loss of volunteers specialized in specific types of technology care work, Wireless Leiden needed to rearrange care work. In the next section I address how the fracture of Wireless Leiden coincided with the emergence of a centralized style of coordination work.

5.4.4 Centralized coordination work

After the fracture of Wireless Leiden resulting in a fragmentation of the people in the Leiden region along the different values of technology practice — virtuosity and communality values on the one hand, and economic values on the other hand — Wireless Leiden did not cease to exist. However, due to the value-rearrangement of technology practices, and the resulting fracture within the group of volunteers, the identity of the Wireless Leiden collective changed. This change in identity was connected not only with a changed value-arrangement, but also with a change in the dominant style of coordination work. As we will see, the dominant style of coordination work had shifted from 'decentered' to 'centralized'. In order to illustrate this change, I analyze the Blaauwberg trajectory and the resulting 'Blaauwberg-report'. This document exemplifies how as a result of the trajectory towards a professional innovation cluster, a centralized style of coordination work materialized within the organization of the Wireless Leiden collective.

The Blaauwberg trajectory

Whereas the debate of the value-conflict on commercialization took place in several locations at once, on Wireless Leiden mailing lists and during various meetings, and between different types of volunteers (volunteer | board members, volunteer | entrepreneurs, and volunteer | hobbyists), the coordination work involved to overcome the value-conflict on professionalization was characterized by its decentered style. What is characteristic of the coordination work involved in the Blaauwberg trajectory is its centralized style. In the first place the number and type of actors involved in the coordination work itself is limited, mostly confined to board-members and professional Blaauwberg consultants. In the second place, what is characteristic, is that the coordination work is concentrated within the board. The Blaauwberg trajectory is coordinated in a top-down fashion. If, during the process, volunteers are invited to join in, such events are carefully orchestrated in order to achieve the desired end-results. The following short overview of the professionalization trajectory as it was coordinated by the Wireless Leiden board, illustrates the centralized style of coordination work in which economic values were constituted as dominant within Wireless Leiden.

The Wireless Leiden board had commissioned the commercial consultancy firm Blaauwberg to advise on how to professionalize Wireless Leiden. The project was paid for by the Municipality of Leiden, which had labeled it as

a "boost subsidy".[56] Karen Sikkema, employed by Blaauwberg, carried out the research for the project, which consisted of several parts. First, individual consultation meetings were scheduled with all board members. Then a round of interviews (mostly by phone) was held with 28 respondents representing the different "stakeholders": currently and previously active volunteers, external actors from the Leiden region such as organizational users, node sponsors, the municipality, spin off companies, participants from neighboring wireless community initiatives. I myself was interviewed as well, in the role of academic student of community innovation. Finally, in December 2006 Blaauwberg organized an interactive workshop organized in their office in which 19 people participated, a combination of active volunteers and board members, and myself as external observing participant. Additionally, Blaauwberg collected some relevant literature, and scanned 16 websites of open source projects and community Wi-Fi networks. All data then was analyzed in a forty page report, entitled "Future vision for Wireless Leiden: Innovative experimenting environment on a higher plane".[57]

The Blaauwberg trajectory thus exemplifies a shift within coordination work from a decentered style towards a centralized style. This professionalization trajectory provides a rich site for analyzing how the style of centralized coordination work materialized into the organization of Wireless Leiden.

In the first place the process of how the trajectory is organized itself exhibits characteristics of a centralized style of coordination work. The whole trajectory is clearly organized in a top-down manner. The top consists here of the small selection of board members who commenced this process of "organizational change", and the Blaauwberg consultants to whom the implement is delegated. The 'bottom' consists of the group of Wireless Leiden volunteers, most of them still actively involved, while a few are no-longer actively involved, but still attached enough the care about the future of Wireless Leiden, which they helped to build in the past.

Wireless Leiden had been organized as a 'foundation' since the moment its initiators had decided to stabilize the name and the aims of the project. This decision carried as consequence that 'volunteers' have no direct influence on the decisions the board of the foundation. In this sense Wireless Leiden is no democratic organization, neither in the form of a direct democracy, nor as a representative democracy, as the board itself decides on new board members. This was a deliberate decision by the initiators of Wireless Leiden who wanted to reap the benefits from becoming a legal non-profit entity, without the burden of slow and difficult decision making if they would have chosen to become an association with members. Previously, the interests of the board members in valuing non-economic values over economic values had overlapped with the interests of the Wireless Leiden volunteers. For example, as sponsor users made available financial resources which were then translated into hardware technologies for building nodes, without gaining direct influence over everyday

[56] The actual Dutch word used was 'aanjaag subsidie'.

[57] Source: Sikkema (2007). Toekomstvisie voor Wireless Leiden. Innovatieve experimenteeromgeving naar een hoger plan. Leiden: Blaauwberg.

technology practices as enacted by volunteers. As such this democratic deficit of the organization structure of Wireless Leiden was not perceived or experienced as problematic by its volunteers. Or, if issues arose, they could be solved by decentered coordination work strategies which included active participation by volunteers themselves. However, at this moment in time board member interests did no longer overlap with the interests of the internal actors — most importantly the volunteers, and to a lesser extent home users as they had traversed into the inside of the network by a process of communification (see chapter Domestication work) — but instead with the interests of external actors primarily interested in economic values. As a result of this development, tensions between board member volunteers, and no-board-member volunteers could emerge, as their valuations of Wireless Leiden had diverged instead of overlapped.

In this respect it is important to note that the impetus for bringing in an external consultancy organization, was solely taken by the board. In taking this decision, the Wireless Leiden volunteers were not consulted, and thus they had no influence over this decision. A decision about a trajectory, however, that could potentially, and would practically, significantly affect the identity of the Wireless Leiden collective. Put differently, although in theory the board had already been a "center of coordination" within Wireless Leiden organized as foundation *in theory*, only now the board started to enact centralized coordination work *in practice* as well. At least that was how many volunteers must have experienced it. Feeling frustrated about being deprived of any official voting rights about the future of the collective they were part of, the only option left for them was "voting with your feet" by exiting from the stage completely. To summarize the process, it suffices to state that the Blaauwberg trajectory was initiated, planned, organized, carried out, implemented and decided on in a top-down manner by a select group of actors in a position of an 'obligatory point of passage' as they were in full control of the Wireless Leiden foundation voting rights, its financial resources and acting as spokespersons representing the collective as a whole. As such, seen from the perspective of the board as obligatory passage point, they had much to win with solid boundaries of the Wireless Leiden collective, whereas until now in practice value-conflicts had primarily been able to solve by a decentered style of coordination work because of the fluidity and the permeability of the boundaries of the collective, which enabled flows into and out of the network in order to deal with balancing the multiple values of technology practice, including economic values.

The volunteer meeting organized by Blaauwberg as part of the professionalization trajectory, offers an insightful illustration of centralized coordination work organized in a top-down manner 'in action'.[58] All volunteers were invited via the volunteer mailing list by Blaauwberg to come over to their office to participate in a meeting aimed at "information-collection" and "brainstorming" about the "future of Wireless Leiden".[59] Although this volunteer meeting event might create the impression that volunteers could influence the outcome of

[58] Empirical data on this event was collected by participant observation.
[59] Source: invitation letter from Blaauwberg to Wireless Leiden volunteer mailing list.

Table 5.1: Blaauwberg volunteer workshop:
(Source: Blaauwberg invitation letter to Wireless Leiden volunteers, 6 December 2006)

Wireless Leiden currently	**Wireless Leiden within 5 years**
- hobby club	- subsidized service for poor people
- open source community	- commercial provider
- social network / club of friends	- part of Leiden Living Lab for Location Based Services
- knowledge network	- way of stimulating locally situated social activities
- experimentation environment	- hobby club
- infrastructure for open use	- provider of free Internet access for visitors through hot spots
- civil society organization for free Internet access	- Leiden-net: platform providing local information (e.g. cultural events)
- organization of technological pioneers	- infrastructure for experimentation with various communication technologies (e.g. VoIP, free telephony, video, etc)
- way of gaining professional or economic advantages	- communication infrastructure for linking offices of companies and organizations
- basic infrastructure for various uses	- taken over by KPN, Google, Orange or other large Internet or telephony provider

the professionalization trajectory, this was actually not the case. Although volunteers were offered a stage to give voice to their opinions or objections, in the end their voices actually carried no weight. This was made explicit through a question by Roland, one of the volunteers participating in the event, when he asked: "Who is going to decide what happens once the report is finished?" The Blaauwberg consultant leading the workshop then responded: "In the end the Wireless Leiden board makes the decisions. They become the owners of the Blaauwberg report." In other words, the volunteers were restricted to offer advice, without any substantial influence on the decisions on the future course of Wireless Leiden.

Another example of the top-down approach of the trajectory, exemplified by this meeting was how Blaauwberg pre-structured the multiple identifies of the Wireless Collective (see Table 5.1). Slide 1, offering an overview of the (then-) current definitions of Wireless Leiden was discussed before the first break. After the break slide 2 was presented as an overview of definitions of what Wireless Leiden could or should become in five years time. Rick, another Wireless Leiden volunteer attending the workshop, questioned why some of the definitions of slide 1 presented before the break, had silently been omitted from slide 2 presented after the break. Or as Rick stated: "In slide 2 some options from slide 1 have disappeared. In the second slide I see a number of services added, while slide 1 gives an overview of what we currently are." Most importantly, the definition of Wireless Leiden as "open source community" present on "Slide 1", was absent from "Slide 2". Only after this omission raised some discussion amongst volunteers, the Blaauwberg consultants then added

"open source community" by hand on Slide 2. Once again, this example shows the influence of the work of Blaauwberg consultants as they were engaged in coordinating this "open meeting" in a centralized manner. As the professional consultants were not only organizing, but preparing, chairing and reporting on the meeting, they were in the position to design the outcome by foregrounding, back grounding or even omitting specific information that would appear in the 'official' finalized and stabilized report, which would be proof-read and edited by the board before publication within the Wireless Leiden on line repository. The centralized character of the coordination work taking place during the value-conflict on professionalization, commanded from the offices of Blaauwberg and the Wireless Leiden board and only then flowing downstream to the rest of the volunteers, stands in stark contrast with the decentered discussions that took place on several mailing lists during the value-conflict on commercialization.

To conclude: key to understanding the dynamics of the value-conflict on professionalization is the shift from enacting coordination work in a decentered style towards enacting it in a centralized style. This strategy had mixed results. Within the local actor-network the centralized coordination work resulted into a dynamics of fragmentation as an effect of volunteers leaving. The strategy of centralized coordination work enabled a "collapsed" folding of Wireless Leiden into a node, which could then be successfully connected to global networks. However, within this dynamic the identity of the Wireless Leiden collective also profoundly changed. This leads us to the question if a centralized style of coordination work is actually compatible for solving value-conflicts as a result of the four different values of technology-practice involved in community-based innovation. In the next section I address this question by contrasting the decentered and the centralized styles of coordination work we encountered.

5.5 Conclusions

Time to wrap up. The argument I developed in this chapter is that practices of innovation by user collectives are not only about the joy of tinkering, the warmth of affective associations or the happiness of doing-things-together, but also about conflicts, tensions and fractures. To re-adjust the image of the development of Wireless Leiden as peaceful process, I described and analyzed how tensions emerged within the collective. Two specific issues were described in detail: commercialization and professionalization. By analyzing these conflicts in terms of Pacey's values of technology practice, it became clear that at the core of both conflicts was the question of how to mix non-economic with economic values within the process of community innovation. This question becomes particularly pressing in two cases. First, if internal actors of community innovation develop an interest in translating elements from the local network into global networks once they realize the potential for 'productizing' useful and ingenious inventions. Second, if external actors develop an interest in translating a hybrid collective into their own network, once they realize such a move could result in economic profit.

Although the interest in both type of translations is driven by the idea of growth, mixing the economic values of market-based innovation in global networks with the non-economic values of community-based innovation can seriously back-fire. Especially, when this results in fracture of the community innovation. Mixing multiple values of technology practice, and more specifically economic values, into the process of community innovation is not impossible. However, it is important to realize that such attempts can result in value-conflicts. Overcoming such value-conflicts is possible, but requires active effort in the form of coordination work.

An important finding resulting from contrasting the two conflict-values in the case of Wireless Leiden is that different *styles* of coordination were discovered. In the first value-conflict the coordination work could be characterized as *decentered*. The space in which the coordination work for solving the value-conflict took place was not confined to a single, centralized locus. In practice, coordination work was dispersed over space and time as interaction between involved actors took place in multiple "negotiation spaces" (Law and Callon 1992), such as on various mailing lists, in open volunteer meetings, in meetings by specific task groups and finally within the board. The main characteristic was that coordination work was mainly focused not primarily on the end-result, but the process itself, to enable all actors to give voice to their interests, concerns and objections. During this value-conflict board members were mainly active in a role of facilitator, enabling discussion to take place in multiple loci at once. In the end, the decentered style of coordination work resulted in a value-arrangement that worked; at least for a certain period of time, until the second value-conflict emerged.

In the second value-conflict on professionalization, coordination work could be characterized as *centralized*. This time the negotiation space in which coordination work took place was mostly confined to the offices in where board members and professional consultants met to devise the strategy for the professionalization of Wireless Leiden. Especially insightful was a volunteer workshop organized by Blaauwberg in which volunteers were invited to let their voices be heard. However, in the 'official' report, the multiplicity of voices had been translated into the economic values of the master narrative of innovation as motor for economic growth. Central to the coordination work in the second value-conflict was the focus on the outcome of the process. Already at the beginning economic values had been ranked over non-economic values of technology practice within Wireless Leiden. The destination of the trajectory was clear from the beginning: professionalization in order to facilitate exploitation of the Wireless Leiden network by external actors. Confronted with such a solidified collective, many internal actors interest in the non-economic values of Wireless Leiden such virtuosity values or communality values engaged in an act of 'voting with their feet' and resigned from the Wireless Leiden collective, in order to continue their technology practices in other settings, for example as part of the Wifisoft-collective.

Over the course of this chapter, a stark contrast emerged between the styles of coordination work in which actors tried to solve value-conflicts during the

process of community innovation and the development dynamics in which these attempts resulted. Ironically, the decentered style of coordination actually resulted in a centripetal translation of the vectors of power, keeping both community and innovation together in a state of coherence-in-tension. While the centralized style of coordination work resulted into a centrifugal translation of the vectors of power, in which the collective fractured and fragmentation of its previously connected elements occurred. This finding raises more general questions if commerce and community can actually immerse or dissolve into each other, or if they are rather insoluble? More research is warranted on what type of efforts are required for mixing gift economies with financial economies, and how to catalyze such reactions. However, attempting to answer such question, whether in theory or practice, one should remain clear of the crucial difference between valuing and valorizing the various technology practice involved in community innovation.

Chapter 6

Conclusion — Rethinking innovation

> "That we cannot fully understand a phenomenon does not mean that it does not exist. That a seemingly growing phenomenon refuses to fit our longstanding perceptions of how people behave and how economic growth occurs counsels closer attention, not studied indifference and ignorance." Benkler (2002a, 446)

In the previous empirical chapters I followed the actors in their 'doing innovation'. In this concluding chapter the focus shifts to rethinking innovation. Based on the study Wireless Leiden as a case of innovation by user collectives, I present an overview of empirical findings and theoretical concepts. And I reflect on community innovation as a notion for rethinking innovation.

This chapter is organized as follows. In section 6.1, I present an overview of previous empirical chapters on types of work involved in innovation by user collectives. In section 6.2, I reflect on how the concepts, introduced to study the innovative user collective of Wireless Leiden, enable a rethinking of innovation in general. 'Giving voice' to the different types of innovation work, this section explicitly aims to intervene in current dominant discourses. Instead of framing innovation in economic values, thereby reducing its richness by rendering its diversity and multiplicity invisible, new concepts enable us telling stories that do better justice to different types of innovation and their enactment in local technology practices. In section 6.3, I argue for studying the cultures of innovation in order to enrich reductionist accounts framed in terms of the economics of innovation. A material-semiotic approach to innovation enables a broader and richer understanding of the diversity of multiple innovation practices. Both market-based and community-based innovation are valuable within their own spheres.

6.1 Different types of innovation work

The central research question for this study was: what different types of work are involved in building and sustaining the hybrid collective of community-based innovation? The four empirical chapters together answer this question by describing and analyzing the different types of work involved in community-based innovation practices: alignment work, domestication work, care work and coordination work. In this section, I present a concise overview of the findings on the work involved in enacting Wireless Leiden as case of innovation by user collectives.

6.1.1 Alignment work

In Chapter 2 I described how the new technology Wi-Fi initiated interest within the Dutch city Leiden. A small group of people developed a shared vision of adapting Wi-Fi as consumer and small-office, indoor cable-replacement devices into a general purpose: outdoor wireless infrastructure. Wi-Fi as infrastructure could then offer free wireless access to digital computer communication network covering Leiden and surrounding areas. For this vision of 'free wireless access for all' to materialize, however, a lot of work was required linking up all the different types of elements into a coherent whole. Neither 'technological' systems nor 'social' communities do emerge automatically: work is involved in carefully aligning different elements into a local network as a hybrid collective. Scholars working within Science and Technology Studies have defined such socio-technical linking activities in terms of creating seamless webs (Hughes, 1986, 1987), heterogeneous engineering (Law, 1987, 1994), or organizing alignment (Suchman, 2000). Emphasizing the massive amount of labor involved in such activities, rather than its heterogeneous nature, I have chosen the notion of alignment work to specify this type of activity.[1]

In cases of innovation by user collectives, material infrastructures mediate information exchange, and work is involved in setting up and maintaining such infrastructures. In creating Wireless Leiden alignment work consisted of careful and skillful tactics of bringing together the right actors in order to solve the main challenges for creating a local network. Most importantly, the actors involved were both human as well as non-human.

Understanding alignment as work enables enriching Innovation Studies' accounts focusing on 'innovation communities' (von Hippel, 2005a,b). These accounts seem to imply that communities automatically emerge and information between its members flows spontaneously and frictionless.[2] In contrast to Innovation Studies literature, my analysis (building on insights from Science and Technology Studies) shows that creating user communities as hybrid collectivesf

[1] Alignment as a notion is common within material-semiotic literature, for instance see Latour (1986a); Callon (1992); Suchman (2000).

[2] The science-fiction jargon 'automagically' in stead of 'automatically' is perhaps more appropriate in this sentence, as the first term emphasizes the emergence of a community as an automatic result of magic as invisible work.

requires strenuous labor. I described the work that was involved in interesting the different types of actors and creating stable links between them for setting up both the 'innovation', in this case a wireless outdoor infrastructure, as well as in setting up the 'community', and the legal entity in the form of the Foundation Wireless Leiden. This alignment work consisted of continuous assembling of heterogeneous resources. The underlying balancing act of interesting and aligning all the different actors consists of much more than the emergent presence of "nodes consisting of individuals or firms interconnected by information transfer links which may involve face-to-face, electronic, or other communication", as von Hippel (2005a, 96) defined innovation communities. To address the point that there is much more to innovation by user collectives than information exchange, I introduced the notion of 'community innovation' to draw attention to matters otherwise marginalized into footnotes, if mentioned at all. In his analysis of innovation communities von Hippel (2005a, 97) strictly separates 'the product' from 'the process' (which is 'community-based'). In contrast, I argue that making such a separation is precisely missing the point of what sets innovation by user collectives apart from other types of innovation.[3] Community (the 'social' side of the Janus face of community innovation) and innovation (the 'technical' side of the Janus face of community innovation) are inseparably intertwined and its identities develop co-evolutionary through mutual interactions.[4]

Within Science and Technology Studies the notion of 'heterogeneous engineering' (Law, 1987) was introduced to address the fact that innovation can only succeed when not only technology is redesigned but society as well (Callon, 1986a). An interesting new finding of this case-study, is that the activity of heterogeneous engineering is not restricted to those actors involved in giving birth to new technologies, but include users of these technologies as well. Although previous literature had already shown how users as actors are involved in opening the black box of technology to redesign technology in such a way to make it fit to local settings of use (von Hippel, 1976; Rice and Rogers, 1980; Kline and Pinch, 1996), what makes the case of the Wireless Leiden case so interesting, is that not only Wi-Fi itself was changed, but society as well, at least on the local level within the wider Leiden area. However, a notion such as 'lead user' (von Hippel, 1986) neglects the heterogeneous engineering aspect of innovation by user collectives, as this concept primarily focuses on technological modification and redesign. Additionally, while 'lead users' only play a role until there specific need is addressed by the markets, 'heterogeneous engineering' in the case of innovation by user collectives is an activity that continues even after commercial alternatives or commercialized versions have become available. During the initiation of innovation by user collectives alignment work is especially important. This means that actors engaging in alignment work,

[3] So-called 'How-to manuals' of free and open source software provide clear examples of the inseparable intertwining of community and innovation as they often offer extensive explanations of the inner workings of 'software code' as well as 'community code'.

[4] Or to quote Johnston (2005, 78) who makes a similar point in the historical case-study of laser holography developed in technical communities: "Technology and technical communities grew together, mutually shaping and stabilizing each other."

talented as heterogeneous engineers, are especially important for setting up innovation by user collectives.[5]

Equally important is that non-human actors are active members of such communities. To emphasize this point, the notion *hybrid collective* offers a better description than *innovation community* because it takes into account the mixed memberships of both humans and non-humans. It is important to note that non-human actors themselves engage in alignment work as well: connecting Wireless Leiden nodes by electromagnetic waves, and also connecting actors by enabling the circulation of intermediaries via infrastructures such as mailing-lists, websites, repositories or physical meetings. As we have seen, alignment work in innovation by user collectives is inherently distributed over human and non-human actors. However, the actual distribution of alignment work is a result of local arrangements developing over time. Some tasks can be delegated to a larger number of actors, increasing 'decenteredness', whereas other tasks can be concentrated between a smaller number of actors, resulting in centralization. In the case of Wireless Leiden alignment work, aimed to materialize the vision of a free wireless into a physical infrastructure, consisted of several activities involving various actors.

Finally, alignment work is an activity that is quite literally taking place, somewhere. Therefore, opposing some trends about the 'virtual' character of communities-on-the-Internet, I argue that locality literally matters as well. As many important actors in the case of Wireless Leiden are 'immobile mutables'[6], locally entrenched (e.g. houses, buildings, Wireless Leiden nodes, etc) place matters as well (and also the new spaces that are created locally).[7] In this sense the city of Leiden is an important actor(-network) in its own right in this tale of Wireless Leiden. The city 'Leiden' is both shaping the community innovation 'Wireless Leiden' as well as shaped by it; and vice versa.

[5] This is what actors involved in Wireless Leiden have identified as well as one of the most important characteristics when they stated that Wireless Leiden could only succeed because of the involvement of persons who where highly skilled in "playing chess on different boards at the same time". Also, the lack of such people skilled in simultaneously solving social as well as technical puzzles, was mentioned as one the main cause of failure in similar community Wi-Fi initiatives.

[6] For the introduction of the notion of 'immutable mobiles' see Latour (1986b, 7), and for a critical re-assessment Star (1995b, 91).

[7] Within Science and Technology Studies, increasingly attention is paid to the locality of digital technologies, and thus deconstructing narratives of non-material, virtual space. For example within the empirical domain of tele-care, Nelly Oudshoorn (Forthcoming) argues "how places matter" in a process of mutual shaping between tele-care technologies and telemedical centers, patients' homes and public space. Gabrielle Coleman makes a similar point in paper analyzing how locality is enacted during 'hacker conferences'. Coleman (2010, 47): "Through a process of ritual condensation and emotional celebration, the conference works to perform and thus confirm what are otherwise more frequent, though more prosaic forms of virtual sociality. This focus allows me to decenter the historical priority placed on digital interactivity and examine the complementary and intertwined relationships between face-to-face interactions and on line interactivity among a group of people often thought of as the quintessential digital subjects."

6.1.2 Domestication work

In the second empirical chapter we came across a new type of work aimed at extending the local network into new places, namely the residences of home users. The first part of bridging the gap between the local Wireless Leiden network and other networks locally situated in people's home, can still be understood as alignment work. For example interesting and aligning commercial Internet service providers to offer free Internet on the Wireless Leiden network, can be understood as part of a strategy to interest home users, whose main interest in Wireless Leiden can be summarized as a 'zero-cost Internet'. Additional parts of such strategies included developing black-boxed solutions for connecting to the Wi-Fi network, effectively delegating many technicalities to pre-configured devices. And finally, an infrastructure of support for home users was created, involving both physical as well as virtual communication channels in the form of information meetings, weekly walk-in consultation hours, how-to and 'connection debugging' manuals, and a mailing list for home users. In a sense, Wireless Leiden created an infrastructure enabling domestication by home users themselves.[8]

However, extending the wireless infrastructure into people's homes involves an additional type of work, namely domestication work. As I have shown this type of work differed in various ways from alignment work. First, it was performed by another type of actor in the Wireless Leiden network, namely 'potential Wireless Leiden home users'. Secondly, the space in which it took place was mainly confined to people's personal spheres, usually their homes. Thirdly, domestication work resulted in an interesting situation in which not only the local Wireless Leiden collective was connected to people's homes, but local home users had become connected to the wireless community collective as well. Home users, to different degrees, became involved as members of the community. This involvement consisted for example of assisting other users at home through the users mailing list, or of giving presentations in public at open information events. In this way they assisted other potential Wireless Leiden home users in their transition towards becoming actual Wireless Leiden home users. Through their activities in the form of domestication work, home users thus contributed back 'gifts' in return for the 'free Internet' offered by the local community innovation. At the same time, the group of Wireless Leiden builders recognized the value of such reciprocal contributions by acknowledging the expertise of the home user (how paradoxically or oxymoronic such a notion as 'the expertise of the non-expert' might seem initially).[9] On the level of the hybrid collective, Wireless Leiden recognized and utilized the specific local expertise of its home users as a separate and significant actor group.

[8] An interesting, but under-theorized term in this regard was coined in (Silverstone and Haddon, 1996, 49), is "pre-domestication", defined as "an anticipation in design itself of the artefact's likely place in (in this case) the home, and an attempt to offer a solution in the design of the object itself to the contradictions generated within the process of technical innovation."

[9] This finding links up with literature describing notions such as local expert (Stewart, 2002, 2007), warm expert (Bakardjieva, 2005), indigenous technical knowledge (Howes and Chambers, 1979), farmer innovators (Chambers et al., 1989).

Most importantly, home users themselves were prepared, based on the principles of reciprocity on which the local gift economy was rooted, to feed back their local knowledge into the community innovation. Which contributed to the further growth and stability of the Wireless Leiden collective. This reciprocal flow of users themselves into the community innovation was termed communification, as they became not only actively involved in Wireless Leiden as a wireless infrastructure, but also as a community of (Wi-Fi) practice. As a result 'sticky knowledge' resulting from their experience and expertise as home users, became 'unstuck' and available for wider circulation, aggregation and giving voice.[10]

Finally, I would like to address the topic of failed appropriation and non-use. In the case of Wireless Leiden we have seen how some actors engage in quite some active effort in order to become connected to the wireless network. In itself it is very interesting to see how motivated and tenacious some actors are in their attempts to align themselves with innovative user collectives, although some of them fail and become non-users. Often these actors, trying to become users of community innovation have very good reasons for doing so. In a sense these non-users could be considered as a type of 'lead users' of community innovation as well. In the case of Wireless Leiden, however, board members did not display an active interest in this specific type of non-users. This is a missed change for further strengthening of the hybrid collective, as not only home users, but non-users as well could be considered as experts. Expertise on non-use might be feed back into the hybrid collective in such a way that a process of communification would not only involve home users, but eventually non-users as well.

6.1.3 Care work

In the third empirical chapter I described the work involved in taking care of the Wireless Leiden collective. Although care work — in relation to technology practices usually described as maintenance or repair work — as a label is well-known and certainly not new, its inclusion as intrinsic part of innovation is rather novel. Therefore, I argue that with regard to innovation, the notions

[10] Interestingly, a similar phenomenon is encountered in the domain of free/libre open source software regarding a specific Linux distribution called Ubuntu. Their success in terms of adoption numbers is widely explained by their strong commitment to focusing to the needs of 'lay person' and 'end users'. One of the strategies for doing so is by deploying 'use scenarios', making diverse types of users and the different user needs explicit. Finally, resources are committed to setting up and maintaining an infrastructure of support for end users, in the form of how-to manuals, wikis and mailing lists to enable and facilitate user-to-user assistance, and to enable aggregation and circulation of the thus developed expertise and specific solutions. A clear illustration is the fact that for example the 'The Official Ubuntu Book' (Hill et al., 2006) devotes a complete chapter on 'the Ubuntu community', and how to connect to it in order to make the operating system work as community innovation. In this regard Ubuntu is certainly not alone: FreeBSD, Apache or SVN all offer similar resources explaining the specific historically grown structures, rules, cultures and governance arrangements of their 'communities' (for example see (The FreeBSD Documentation Project, 2010), (Apache Software Foundation, 2004), (Subversion maintainers, 2010; Fogel, 2005, 2007).

of learning-by-doing, learning-by-using (see Rosenberg, 1982) or learning-by-trying (Fleck, 1994) could be extended with 'learning-by-caring'.

Based on analyzing the empirical data, two different types of care work were distinguished. In the first part of the chapter we followed the so-called 'node adoption volunteers'. It was argued that their specific type of caring activities were best understood as an act of 'caring for technology'. To capture the affective associations between human and non-human actors involved and driving this particular type of care work, the concept 'warm user' was introduced. This finding of the importance of affective associations between human and non-human actors for the sustainability of the hybrid collective suggests interesting starting-points for both theoretical research (building on previous work by Verbeek, 2000, 2004) as well as for those interested in facilitating practices of community innovation.[11]

In the second part of the chapter I followed another category of Wireless Leiden volunteers engaged in care work. One of the striking observations was that this particular type of care work often included creative redesign of the artifacts that had broken down or stopped functioning correctly. In this manner, care work on individual artifacts became part of iterative cycles of improving design, based on the feedback of individual, locally situated, solutions into the collective. And thus enabling artifacts to become more robust and more resilient to forces of resistance. To capture the ingenuity of the actors involved in this innovation-by-caring, I introduced the notion of the 'virtuoso volunteer'. This type of care work actor is intrinsically motivated by 'tinkering with technology', having an intimate affair with technology as part of a broader identity project.[12] For these actors, community innovations provide a stage for performing technical competencies as part of their masculine identities. It is true that in the case of Wireless Leiden (and many similar technical hobby communities and open source projects) the population of actively involved volunteers are predominantly male gendered. This is, however, no new finding, as the notion of technology has become male gendered (Oldenziel, 1999). What is more interesting, and in my view a new finding, is that in this highly male gendered environment, care work as a female gendered type of activity forms an essential part of how community innovation works. Although much of the care work is located 'back stage' and hence 'invisible', it is of paramount importance for the stability and sustainability of community innovation. Once we conceptualize repair and maintenance, not only in terms of articulation work (building on the work of Garfinkel, 1967) but in terms of care work, suddenly male gendered actors are involved in female gendered activities everywhere. Especially when we consider technology as identity creation projects, the role of care work is particularly interesting as female gendered activity in the construction of male gendered identities. So care work is not only targeted

[11] For instance the notion of warm user would enable an interesting re-analysis of the factors of success for small-scale sustainable energy-saving projects as described in Ornetzeder and Rohracher (2006). On the contrary, a decreasing involvement of warm users might help to better understand a dynamics of 'waining technological citizenship' as a cause for failure of previously successful bottom-up initiatives in local ecological communities, for example as described in Cuijpers (2006).

[12] This finding resonates with the work of Sherry Turkle, for instance see Turkle (1984, 1995, 2007).

towards the proper functioning of technical devices, but involves the proper functioning of identities as well, that is identities of manliness constructed along lines of technical competencies. In community innovation, care work can be understood as part of identity projects, enacting and maintaining specific images of personal identities. In the process of community innovation, with Wireless Leiden as case, not only a stage for performing identity work is provided. Those involved integrate the aura of 'innovation' of the collective into their personal identities to display their technical competencies as well.

6.1.4 Coordination work

In the fourth empirical chapter I described and analyzed two conflicts that took place within the development of Wireless Leiden as community innovation. To analyze the two conflicts I applied Pacey's notions of values of technology practice. Pacey's distinction between three different types of values, namely economic values, virtuosity values and user or need values, were mobilized as sensitizing concepts for analyzing the empirical data. On the surface the first value-conflict was on the issue of commercialization, and the second one on the issue of professionalization.

Starting with Pacey's sensitizing concepts[13] I argued how the two value-conflicts both centered around the issue of how to deal with economic values within community innovation. This is an important question, as issues on economic values seem to emerge in many other cases of community innovation as well. Managing the tensions emerging as results of the different values of technology practice, is what I termed coordination work.

In addition to the three types of values described by Pacey, I discovered a fourth one, namely communality values. Especially in community innovation, communality values are of vital importance for keeping the collective together and unpaid volunteers interested and actively involved.

Based on analyzing the empirical data of the two value-conflicts on economic values, two different styles of coordination work were found. I characterized the first style of coordination work as *decentered*. This type of coordination work was mainly internally focused on the local network of the Wireless Leiden collective and actors actively involved within it.

The second type of coordination work, which emerged as dominant style during the second value-conflict on professionalization, I characterized as *centralized*. Contrasting with the first value-conflict, the second one took place in 'centers of coordination' such as the official Wireless Leiden Foundation office, or the office of the commercial consultancy organization Blaauwberg. The centralized coordination work was much more externally focused on global networks and actors outside the Wireless Leiden collective.

Besides the difference in style of coordination work, its outcome in terms of dynamics differed as well. I described the dynamics of the first value-conflict as 'coherence-in-tension'. In contrast with the first value-conflict, during the second one, a dynamics of fracture and fragmentation occurred, as a result of the

[13] On the notion of sensitizing concept see Strauss and Corbin (1990).

centralized style of coordination work. Although the centralized coordination work emerged as the dominant style during the second value-conflict, certainly not all actors involved within the Wireless Leiden collective were charmed by it. However, lacking any official voting rights to actually decide on the course of the Wireless Leiden Foundation as legal entity, the only move available to most volunteers dissatisfied with the situation, was to vote with their feet and leave Wireless Leiden all together.

This finding of fracture is important, because it seems to suggests that there are limits to the fluidity of the collective identity in cases of community innovation. When the identity shifts to much, involved volunteers might become to feel estranged and unable to connect themselves as subject-networks to the collective identity of the actor-network. Especially where initiatives seem to cross the line between not-for-profit to for-profit the risk of fracture and fragmentation might become reality.

The same risk applies to shifts in style of coordination work from decentered to centralized ones. Although not the case in the Wireless Leiden collective, complete lack of coordination work also runs the risk of community innovation falling apart.[14] However, overdoing it in the form of a strictly hierarchical style of centralized coordination work might run the risk of fracturing the hybrid collective. The case of Wireless Leiden seems to suggest that a decentered style of coordination work has the best fits with community innovation and keeping the hybrid collective together.

Just as hydro-phobic fluids such as oil and hydro-philic fluids of water do not mix very well, the same might hold true for economic values ('markets-philic') and communality values ('markets-phobic'). One can shake as hard or long as possible, but inevitably a boundary between the two emerges, in which one type rises to the surface, floating on top of the others. In the case of community innovation, unpaid volunteers seem to be moved by other values than the economic values which are so attractive to profit-seeking entrepreneurs. This is not to say that one type of values is more important than the other, but that in the specific setting of community innovation, prioritization of economic values carries the risk of estranging the actors from the collective, resulting in a dynamic of fracture and fragmentation.

6.1.5 Focusing on work

Based on the previous chapters, I conclude that an explicit focus on different types of work involved in innovation by user collectives is important because it enabled to show the value of different types of actors and their involvement in innovative practices. Not only 'elite experts', but also users as 'experts of everyday use' as well. Not only the value of 'technical tinkering', but the importance of 'social engineering'. What makes innovation by user collectives

[14] This observation is based on preliminary research on other community Wi-Fi initiatives in the Netherlands such as the 'Amsterdam Wireless Collective' which was organized in a truly anarchistic manner.

work, is the involvement of multiple, diverse actors.[15] As we have seen in chapter 1, the work of many of these actors is largely invisible in dominant discourses on innovation. This PhD-thesis therefore aimed to show the link between a highly visible wireless innovation in the Netherlands, and the less visible Wi-Fi users who initially gave birth to it and subsequently raised it. This tale of innovation enlists the complete actor collective in the credits. Not just the main protagonists of innovation such as individual inventors or shrewd entrepreneurs, but the supporting roles of groups of home users, warm users or infrastructural technologies as well.

6.2 Different innovation vocabularies

Words matter.[16] Different words convey different meanings. Words and metaphors are framing devices for how we understand the world.[17] Words do something, they perform work, they enact worlds. By giving things a name, we breathe life into them. Or the opposite; not naming things is a method of silencing, of keeping them out of discourse. Language is a form of politics. In the words of John Law and Vicky Singleton (2000, 767): "To tell technoscience stories, is in some form or another, to perform technoscience realities." If telling tales is no innocent activity, this raises the question on how words, in this case as part of an academic vocabulary, could contribute to telling tales of innovation by user collectives. A persistent problem in current Innovation Studies literature, is its unreflexive use of the term innovation. Especially when studying innovation by user-collectives it is important to recognize the difference between innovation as 'lived experience' and 'analytical tool' (Oldenziel, 2006, 481).

After visiting the Wireless Leiden collective as a guest, and aggregating my observations into theoretical constructs, my aim with this study is "giving voice" to the numerous actors who make community innovation work. To do so, in this section I present 'a convenient vocabulary'[18] for foregrounding all the actors and their activities involved in making community innovation work — even backstage.

Throughout the previous chapters my aim was to render an novel phenomenon alive — at least in innovation research literature as it already was alive and kicking by itself "out there" — by christening it "community innovation" while putting empirical flesh on its theoretical bones by telling the tale of the birth and growth of the Wireless Leiden collective.[19]

[15] Principle of symmetry between failure and success; human and non-human; user and producer (as these are results, and hence need to be explained themselves, ("explanans versus explanandum") (also see Wyatt on different types of principles within STS).

[16] See Oldenziel (2006, 483-4) stating: "If the linguistic turn over the last decades has taught us anything, it is that words matter because they frame social reality and become hardened in material practices. [...] They are the expression of social communities and power struggles, efficacious weapons that can sharpen the tools of some groups and blunt the effectiveness of others."

[17] See Lakoff and Johnson (1980) on metaphors. On words as 'ideographs', see McGee (1980). For a critical analysis for "metaphors at work" in relation to issues concerning Internet, see Wyatt (2004).

[18] See Akrich and Latour (1992).

[19] In a sense this is also what we have seen on an empirical level in the case of Wireless Leiden. Once

Words in the form of concepts bridge between practice and theory. In this section I shift the focus from the empirical tale of a community innovation in particular, to community innovation as a more abstract concept in general. In order to bridge this gap between data and theory, between the specific and the general, let us have a look at the concepts that resulted from analyzing the different types of work enabling specific types of distributed innovation.

6.2.1 Community Innovation

As I described in chapter 2, the concept of community innovation is grounded in the material-semiotic approach to technology. In this light the choice for material semiotics as central approach for this study was a deliberate one. As a method for describing how hybrid collectives emerge I chose to lend the strength of the strand of material semiotics literature. Borrowing the 'infra-language' of actor-network theory enabled describing the different actors involved (both people and machines) and their activities. Choosing such a neutral wording enabled me as an analyst not to be bound by applying restricting labels such as designers and users, or producers and consumers as static entities, while in practice actors can play multiple roles at once depending on time and location (e.g. consumer of certain technologies at work, while contributing as designer to open source tools while at home).

In chapter 2, I defined community innovation as a type of innovation in which the two constituting parts, namely the community and the innovation, cannot be separated and are two parts of the same coin. Due to modernist tendencies of purification between the 'technical' and the 'social', or between 'human' and 'non-human', analytical focus is usually directed only at one of the two at a time. However, in order to fully grasp what community innovation is about, and how it works, these two different views cannot be separated.

Using theater-inspired language introduced by Goffman, looking at a play as it is performed front-stage is a beautiful experience, however how it is done can only fully be understood be taking into account the simultaneous support work performed backstage (Goffman, 1959). In this manner the methodological principle of symmetry between human and non-human actors, and the normative stance 'giving voice' to the invisible work going on all the time, are related as well.

What sets community innovation apart from other types of innovation is the key defining characteristic that the community is inextricably bound up with the innovation itself. Although the constituting elements — community and innovation — could exist apart from each other, such separation would invalidate their symbiotic synergy which enables innovation by user collectives.

Although the innovation might be removed from its community (through brute external force or internal dissolvement), such a seperation results in such a profound character change that it invalidates the label community innovation. On the reverse the involvement of a community in the 'journey' of an

this specific hybrid collective acquired its own name, and additional status as legal entity of its own in the form of a foundation, it started to develop its own dynamics, as an emergent macro-actor.

innovation does not automatically imply an instance of community innovation. Not only innovation scholars have identified 'users as sources of innovation', but commercial enterprises themselves as well. An example of such recent trend is the notion of 'crowd-sourcing', in which labour is delegated to consumers as an unpaid workforce, reminiscent of a 'proletariat' of the Digital Age.[20]

So what are the advantages of analyzing innovation by user collectives as community innovation? The first advantage is foregrounding the different actors and their multiple roles. The concept allows to analyze growth and stabilization of the innovation as the result of the activities of a community of actors who play different roles at once, for example some are users and producers simultaneously. The second advantage is foregrounding the different types of work. The concept of community innovation foregrounds work required for innovation by heterogeneous collectives, most notably the coordination of the alignment and management of the various actors. The third advantage is foregrounding its hybrid composition. The community innovation concept portrays innovation as an evolving hybrid collective in which both human and nonhuman actors are active and become aligned. The social and ideological characteristics of the innovation community and the type of knowledge and expertise available have shaped the technological, material aspect and vice versa.

Most importantly, non-human actants play a key role as 'sources' of innovation by hybrid user collectives such as Wireless Leiden. Usually tales of innovation feature technologists as main protagonists; the entrepreneur as hero, as network-building champion. A well-known historical example is inventor-entrepreneur Thomas Edison (see Hughes 1983). A more recent example is Steve Jobs, leading the American company Apple. However, innovation does not necessarily be restricted to a top-down process of 'diffusing' from a centers-of-translation towards other places and spaces. As we have seen in this case-study, sometimes a tale of innovation can also start with a single technology, which interests actors around it, initiating a process of mutual shaping in which all actor identities are changed by becoming part of a larger collective entity. What makes this case-study of 'community Wi-Fi' so interesting, is that 'the prime mover', so to speak, is not a human but a non-human actor. Without Wi-Fi, no 'community Wi-Fi'. This observation might seem trite or trivial, but it is not.

The point I want to make about the key role of non-human actants, relates specifically to innovation by user collectives. Whereas von Hippel frames the 'source' of user-initiation innovation as the name already states, exclusively 'within' the user, in this PhD-thesis I argued for a broader explanation allowing the inclusion of non-human entities as well. It is not only the individual user who counts, or the individual technology for that matter, it is the combination of different entities as they start to define each other during enactment within use practices. No user without technology, and no technology without user. It is the hybrid-(user-technology)-entity-in-action we should take as unit of analysis for

[20] For a 'critical analysis' of 'Web 2.0 business manifestos' and the agency of users in relation to the generation of content see van Dijck and Nieborg (2007); van Dijck (2009); van Dijck and Nieborg (2009).

understanding the sources of innovation. As I showed in the previous chapters, the innovative agency is distributed, hybrid and collective. And non-human actors play a key role in these hybrid collectives.

However, not all technologies are equal when it comes to their enabling and restricting agency in relation to innovation by user collectives. The 'script' of different technologies draws different geographies of involvement around them, delegating different types of work and responsibility to different types of actors. Consequently, a technology is only 'guiding' actors by means of its script with more or less force, depending on what powers (whether material or symbolically) of other entities can be translated into its own actor-network. Equally important, improvisation, resistance, denial, and ignorance can offer alternative options. However, these insights do not yet answer the question of why certain technologies invite users to innovative or not. Von Hippel suggested that user needs should be considered as one of the main explanations for why users start innovating. This is a rather rationalist, human-biased explanation. Sometimes, people also 'fall in love' with a certain technology, and an affective association between the entities involved emerges. Without a direct need, a journey is started to explore the new spaces into which an entrance is offered by novel use practices.

So in the case of Wi-Fi one might wonder, what it is in the technology itself, that turns an actant into a source of action for innovation by user collectives? What are its community innovation 'affordances' (Hutchby, 2001) in this regard? Michel Callon (2004) introduced an alternative for affordances, namely the notion of 'promissions'. A playful combination of the English words 'promiss', for inviting action, and 'permisson', for allowing action as well. In the case of Wi-Fi, its promissions were its invitive character for wireless experimentation in combination with its explicitly non-discriminatory permissive 'access for all' character built into its standardized regulations for use. Technologies based on spread spectrum techniques, and thus quite similar to Wi-Fi, have already existed for decades, and they never spawned innovation by user collectives. However, in those cases these technologies and their actor-world's promissions actually resembled 'prohibitions', by excluding non-professional users without significant financial resources by requiring state-issued use-licenses. In the United States for example, use of spread spectrum techniques for telecommunication purposes was either restricted to the military or to corporations (often telecommunication providers) able to bear the costs of acquiring pricey licenses. To conclude: my argument is that the technologies themselves, and more specifically, their promissions, actively shape how user collectives are involved in innovation.

6.2.2 Diversity

Understanding innovation by hybrid collectives requires not only attention to the different types of non-human actors and their promissions, but requires attention to the diversity of human actors as well. Based on the previous chapters we can conclude that in community innovation, the mixture of unpaid

volunteers, hobbyists, amateurs, users, and sometimes paid professionals involved in innovative technology practices differs from the mono-cultural blend of paid experts and professionals dominating commercial innovation. Although many Innovation Studies' accounts give credit to the role of users in innovation, they lack attention to the full diversity of actor types. Most studies on user innovation primarily focus on initiators. In current user innovation discourse the dominant imagery depicts primarily 'individual heroes', an 'expert elite' consisting of 'lead users', 'user-innovators' and 'user-entrepreneurs'. Although these actor-types might be the dominant ones representing innovative technology-practices rooted in economic values, differently valued technology practices include many more types of actors. The explicit aim of this section is to adjust that image, by foregrounding the diversity of the actors involved, and highlighting the importance of "home users" and their inventions and innovations resulting from their technology practices in everyday life. Hence, I argue for a less restrictive, more inclusive approach. Based on detailed descriptions of how community innovation is made to work, I claim we should analyze the activities of other types of actors (such as explorers, extenders and coordinators) as well. Taking into account the importance of diversity, enables us to have a look at the full spectrum of actors involved in innovation work. In turn this results in a better understanding of how actors are actually 'doing' community innovation.

So if diversity is important, how does it actually matter for innovation by user collectives? In this section I present a short overview of the colorful collection of actors as encountered in the Wireless Leiden case. However, not the detailed descriptions of the many actors themselves are important, but the fact that all these accounts of the different actors are relevant for understanding community innovation is what counts here. The important point is not that there are differences between actors — implying one type of actor might be better or more valuable than another — but acknowledging the value of diversity itself. My claim is that if one aims to study innovations by hybrid and distributed user collectives, one needs to be sensitive to the diversity of all types of actors involved. An a priori bias towards 'innovation heroes' while studying community-based innovation, creates a framing preventing an outlook to the full panorama of innovation actors.

Extending the argument of the previous section on the hybrid nature of user-collectives, I argue that for making community innovation work, the diversity of actors includes not not only various types of technologies, but various types of humans as well. What is setting apart community innovation from other types of innovation, is exactly this diversity of actors types enacting innovative technology practices. Not only *initiators* are important, often figuring in their roles of lead users, user-innovators and user-entrepreneurs in many Innovation Studies accounts on user-initiated innovation. Making community innovation work involves a diversity of actors: initiators, explorers, extenders, non-users, all have different types of relations with the technologies of practice.

6.2.3 Warm users

Within the process of community innovation, one type of actors is important as well as invisible, namely warm users. Whereas in many innovation studies literature, initiators and explorers steal the show, there is more to community innovation than the involvement of virtuoso volunteers. Whereas this latter group are usually caring *about* technology, sometimes even reaching levels of fanaticism and fundamentalism, these elite experts are not automatically interested as much in caring *for* technology. Whereas tinkering practices rooted in its pleasures and powers are based on 'mastering' technology, technological caring practices are rooted in 'nurturing' technology.[21]

Both virtuoso volunteers and warm users can be highly emotionally involved with and attached to certain technologies. Both type of actors share a certain love for technology, in which elements such as intimacy, passion, and commitment all can be identified.[22] However, the attachment between virtuoso volunteer users and warm users is based on different types of affective associations.[23] Virtuoso volunteer users resemble the image of the hacker, in the positive meaning of the word, and not the pejorative depiction in popular press. For example Sherry Turkle speaks of computer culture, as being dominated by images of competition, sports and violence. The intimate relationships between machines and virtuoso users provides 'protective worlds'.[24] However, other associations with technology, in the form of connections of care are also possible. This is where warm users enter the picture. In the same manner as with virtuoso users, the focus is on technology that is 'ready-at-hand', instead of 'present-at-hand', to use the post-phenomenological terminology of Verbeek (2004). However, the being ready-at-hand state of the user-technology relationship is not an aim in itself, but a consequence of the breakdown of the present-at-hand state. The main aims of warm users are rooted within use practices, in actually using the technology. However, their affective association makes them also provide care whenever the technology needs it, in the form of cleaning, (re-)configuration, maintenance or repair. This in contrast to technology-virtuosos whose main interest is in the technology in the present-at-hand state. Practices of actual use, in which the technologies move into a ready-at-hand state are an after wards affair, a demonstration of previous successful domination to themselves or peers.

Summarizing, I conclude that warm users are an important group of actors in community innovation. In this PhD thesis I showed how the concept of warm users contributes to the analysis of how community innovation works

[21] On the 'powers and pleasures of technology', see Hacker (1989); Faulkner (2000); Kleif and Faulkner (2003).

[22] See Russo (2009).

[23] See Orlikowski (2000, 423): "Additionally, future research could benefit from attending more carefully to the meanings and emotional attachments that users develop for the technologies they use. Beyond the skepticism displayed by some of the consultants within Alpha, my empirical data did not capture the richness of users' affective connections with technology. Understanding these attachments and meanings could offer richer explanations for the range of structural responses enacted by users as they engage with technologies in practice."

[24] See Turkle (1988).

by linking the visible community innovation as a socio-technical novelty — for example a free wireless infrastructure, a free operating system, or a free on line encyclopedia — with all the invisible innovation work performed backstage. The warm user concept helps making visible those actors engaged in doing community innovation: not only the small group of elite expert "initiators" of community innovation, but also its usually more numerous "user" base. Additionally, the concept of warm users shifts the affective character of the human-technology association to the foreground.

6.2.4 Reciprocity and communification

In addition to people helping technologies-in-need in the case of Wireless Leiden, people are helping other people as well. Because the experience of actually using Wireless Leiden is certainly not always a smooth one, but usually involves additional configuration at the very least, or technological wizardry at the most, or something in between, especially home users, puzzled by broken connections, are often in need of support.

In order to solve their problems, such users have no official company to turn to for solving their problems. What sets apart using technologies resulting from community innovation from those resulting from commercial innovation, is the usual lack of paid professional support in the first instance versus the second. This means that service and support work that is usually the responsibility of paid workers in the case of commercial products, in cases of community innovation the same type of work is delegated to unpaid volunteers.

Crucial to understanding the infrastructures of support in the case of Wireless Leiden, is that the process of community innovation is not rooted in a market-based economy, but in a gift-based economy. Although there is no money paid for service and support work, other types of reimbursements are expected, although never formally required. Understanding the support arrangements in community innovation requires a broader perspective on economies, not only limited to financial transactions, but gift-based transactions. Such a gift-based economies are based on the principle of reciprocity. Although there is no formal quantification (the what) or temporalization (the when) of the return-transaction, gift-receivers are expected to return gifts. So, gifts are not free, but usually imply reciprocity.

Examples of reciprocal gifting by users in return for help consists of writing documentation, answering other users' e-mails, giving presentations. The economy that enables Wireless Leiden to function is thus not a financial one, but one based on gifting based on 'warm' relations. Where in the commercial innovation users pay money to a company to compensate for the salary of repairmen, in the case of community innovation, users 'pay' the community by donating resources back to it in the form of time, energy or concrete products such as manuals, documents, bug reports, or answers to questions. In the situation of a commercial Internet access subscription technologies are expected to be stable black boxes, with companies expected to fix problems. However, in relation to community innovations, users are more forgiving and prepared to

participate in helping fluid technology in case of a failure.

What is interesting is how such return-gifts are channeled back into the hybrid collective. In the previous section on users who care, the focus was on individual user-object pairs. Warm users as well as virtuoso users often form pairs with specific individual artifacts and technologies. Warm users usually care for the near-by nodes that provide the connection between their homes and the larger wireless infrastructure. Virtuoso users often specialize in a specific element, such as designing and building outdoor node cases or writing and maintaining a specific piece of software. This raises the question of how all this localized individual user-technology bonding is folded back into the hybrid collective. To understand this process I introduced the concept of *communification* understood as a kind of inverse domestication. Whereas domestication is a process of 'taming technology' aimed at aligning artifacts within use practices, communification is a process of 'socializing users' (and their practices) into the distributed hybrid collective. Both processes deal with alignment, one of alignment between specific technological devices and users, the other between of users and specific technologies resulting from community innovation.

Most importantly, with the introduction of communification as a concept I aim to to connect previously disconnected strands of literature, with notions such as 'domestication' (Silverstone and Hirsch, 1992) within Media Studies on the one hand, and notions such as 'community joining' (von Krogh et al., 2003) within Innovation Studies on the other hand. However, I would like to emphasize that what would enable such a bridge-building in the first place, is extending the 'range' of such insights to include not only "active developers" but "active users" as well. In the end the process of reciprocity is not restricted to actors within innovation collectives with a label such as developer or designer, but includes all the actors involved, perhaps even spanning selective users and non-users of community innovation as well.

6.2.5 Multiple values of community innovation

Values also matter. Actually, values touch to the very core of innovation by user collectives. If we want to understand why different types of actors participate in different types of community innovation practices, we should focus on what values are articulated as important for their involvement. The core of my argument is that value cannot be reduced to financial dimensions, but that there are multiple values involved instead.

In order to make my argument about the importance of the multiple values I referred to Pacey's distinction between economic values, virtuosity values and user or need values (Pacey, 1983). In this PhD thesis I emphasized a fourth type of values as well: communality values. I argued that communality values should be considered as one of the characteristics that sets apart community-based innovation from market-based innovation. Communality values, serving as rules for action for practitioners involved in community innovation, stress that these individuals are being part of a larger, cooperative collective. By

'doing it together', participants enact communality values as rules guiding their community innovation practices.

This 'doing things together' is based on reciprocity rooted in a gift economy in an identical manner as processes of communification are. One might as well state that communification, as a process of enacting reciprocity between individual user as practitioner and the hybrid collective as provider of Free Internet, is an example of how communality values, as rules for action, shape practices of both domestication as well as communification of community innovation technologies.

Stating that communality values are one of the specifics of community innovation practices, raises the question what happens when the 'character' of a community-based innovation initiative changes in a way that backgrounds communality values. The empirical chapter on coordination work proved that this dynamic is not only a hypothetical development, but an empirically observed one as well. In the case of Wireless Leiden the strategy of back grounding communality values by subordinating them to economic values proved to be a double-edged sword.

On the one hand, the strategy of foregrounding the economic value, enabled board members to interest and align themselves with new external actors, resulting in new chains of association enabling the circulation of intermediaries in the form of subsidies flowing towards Wireless Leiden entrepreneurs and inversely flowing program reports towards government agencies. On the other hand, this strategy restricted the affective associations between Wireless Leiden and its volunteers, who had problems with mixing the financial economy of the global network in which external actors were situated, with the gift-based economy of the local network.

Additionally, this strategy involved stabilization of Wireless Leiden in order to become a 'reliable infrastructure' as a necessary precondition for its 'use' as test-bed for developing new commercial services and products by external actors. This process of closure, involving black-boxing and standardization of the underlying technologies, also implied a different geography of responsibilities for Wireless Leiden volunteers, and more specifically, less free and more restrictive space for experimentation, thus decreasing virtuosity values as well. Therefore, the specific dynamics of the Wireless Leiden case, in which the communality values and virtuosity values were made subordinate to economic values resulting in fracture and fragmentation, raises the question if community innovation can remain stable and sustainable without attending explicitly to communality values.

Based on my analysis of Wireless Leiden I tend to conclude that communality values are crucial for sustaining community innovation. Also it is important to note that after fracture and fragmentation had occurred over the primacy of economic values, the identity of the Wireless Leiden had changed.

Regarding the multiple values of technology practice, the focus was primarily on the human part of the population of actors involved in community-based innovation. More specifically, the values of technology practices offered insight into the multiple motives for being involved in innovative user collectives. This

approach resulted in a better understanding of the 'socio-gram' of the work process of community innovation. However, this is only one part of answering the general question of how to characterize community innovation. Adhering to the principle of symmetry between human and non-human actors (Callon, 1986b), the other part of the answer lies in addressing the 'techno-gram' (Latour, 1987) of community innovation. Therefore, the following section attends to the population of *non-huma*n actors, and their active involvement in community innovation.

6.2.6 Fluid and open technologies

What can we conclude about the characteristics of the technologies involved in community-based innovation? My main claim is that technologies of community innovation share two distinctive characteristics: fluidity, and related to it, openness. Both notions deal with the boundaries between technologies and surroundings. More specifically, fluidity concerns the form of these boundaries, while openness relates to their function.

Technologies involved in community innovation can be considered as fluid technologies.[25] The most relevant, characteristic element of fluid technologies is their lack of solid and sharp boundaries, they contain their environment (de Laet and Mol, 2000, 252).[26] This also implies that a fluid technology has multiple identities, and each identity comes with its own different boundaries.

But there is more to say about the characteristics of technologies involved in community innovation. Therefore, I would like to shift the focus from fluidity as main characteristic of the boundaries of technologies to openness. Let me explain why moving from fluidity to openness can enrich the analysis of the technologies of community innovation.

A fluid is not *a priori* open. The link between the notion of fluidity and openness is that both point to boundaries that are not sharp and solid. Fluidity emerges as a characteristic that is specific for technology lacking solid and sharp boundaries. Openness points to an underlying mechanism, to how these boundaries have become and remain not sharp and not solid. Mol and de Laet already point in this direction stating that, not only creating boundaries that are sharp and solid requires work, but in order to create the inverse, namely boundaries lacking sharpness and solidity, involves a specific type of work as well. Openness relates to "reflective practitioners" explicitly stressing access, explicitly "opening up" technology, by designing a built-in openness, facilitating

[25] The notion of fluidity, introduced by Annemarie Mol and John Law (1994), aimed to enrich the material-semiotic approach for studying technoscience, by introducing a new metaphor for thinking beyond the classic topology of regions as well as the more recent topology of networks. The notion of fluid technologies is introduced and elaborated by Annemarie Mol and Marianne de Laet telling the story of the Zimbabwe Bush Pump (de Laet and Mol, 2000).

[26] Additionally it is nice to have some positive examples of successful technology transfer in Science and Technology Studies, in addition to the various cases of failure. For two well-known case-studies describing and analyzing failed transfer of technology from "the West" to "the South" see Akrich (1992, 1993).

access to the inner workings of a technology during different types of technology practice.

More specifically, openness ensures access to its normally invisible innards, in order to enable a shift from use practices in which the technology functions as a 'intermediate' means-to-an-end, to repair practices during which the technology is relegated to an end-in-itself. In this sense, openness could be understood as an explicit effort towards an 'extended' version of ergonomics, facilitating (temporarily) interaction with technologies as end-in-itself, in addition to how ergonomics is usually understood as facilitating 'everyday' interaction with technology as means-to-an-end. Open technologies not only facilitate interaction during use, but also facilitate practices of installation, maintenance, repair, redesign, recycling and removal.

In the case of Wireless Leiden openness is an element that is key to its organization.[27] From the very beginning of the initiative to assemble a Wi-Fi-net in Leiden as a cooperative collective, openness was one of its key organizing principles. Technologies can be open in different ways: based on open standards, based on open source software, hardware and orgware, or based on open access. The first form of openness encountered in the case of Wireless Leiden is openness of the ether. The Wi-Fi technology that ignited the initiation of community wireless networks such as Wireless Leiden, lends its very existence to the governmental policy of opening up restricted parts of the ether for anyone to use in the domain of wireless computer networking. Nowadays, free access of specific parts of the ether might have lost its original aura of attraction. Especially now our present-day world is populated with an abundance of low-cost wireless digital devices. Nonetheless, open access of the ether, or more specifically, access that is open to anyone without government-issued expensive licenses, is key here. Without a commons in the ether for open-air computer communication, community innovation could not have existed, at least not in the various forms, extended scales and high numbers as we know it today.

The second form of openness characteristic for community innovation such as in the case of Wireless Leiden are open standards. The family of IEEE 802.11 standards — marketed under the name 'Wi-Fi' — form an example of a standard that is open. Although the precise meaning of openness in relation to standards is contested (see Abbate, 1995), in relation to Wireless Leiden, it is relevant in so far that all devices that are marketed as 'Wi-Fi' devices are guaranteed to be able to interact with each other, irregardless of its brand or producer. This is also relevant, because for a while technologies competing with Wi-Fi were available, as commercial products in the case of HomeRF or in development in the case of HyperLan, which were not mutually compatible. Without the availability of wireless devices adhering to a single open standard, the creation of community innovation such as Wireless Leiden, would not have been possible.

Thirdly, Wireless Leiden is built on open source software. Its infrastructure

[27] The articles of association of Wireless Leiden as a non-profit foundation already in 2002 clearly stated that: "The foundation aims to [...] build their own broadband computer network in Leiden and its surroundings, by using among others wireless technologies, open source and open standards."(Source: Article 2, articles of association, Foundation Wireless Leiden, 2002-09-02).

relies completely on a skillful amalgam of different software, which all share the characteristic that they provide open access to their source. Source code is to software, what the 'underground parts' are to a water pump. Invisible during normal interaction, however, when a technology breaks down, access to these inner elements is necessary in order to enable replacement and repair. In the case of software, access to its source code provides its users the freedoms to use it, study and adapt it, improve it, and redistribute copies to a wider community.[28]

To conclude: the notion of openness in addition to that of fluidity, grant further analytical insight into the specific arrangement of boundaries between technologies and actors involved in community innovation. Fluidity and openness are both result as well as precondition for community innovation as a process. However, it is important to stress that characteristics of fluidity and openness are no *a priori* traits of technologies as 'gifts of Nature'. These characteristics emerge within the interaction of technology practices of community-based innovation based on virtuosity, user/need and communality values on the one hand, and the materiality of specific technological designs on the other hand. Out of this interaction a path emerges, guiding further development and use.

Consequently, key to understanding what sets the technologies resulting from market-based innovation apart from those of community-based innovation is the "closedness" of the first versus the "openness" of the latter. The concept of fluid and open technology helps to contrast it with black-boxed technology, which is the usual phenotype of technologies that emerge as products of market-based innovation. Important to note is how the process of innovation, and its degree of openness or closedness, and the strictness of boundaries between different actors, practices and locations, are mirrored in the material design of such technologies. Additionally, whereas black boxed technologies fit in well with a strategy of silencing user values or communality values in order to maximize the economic value, fluid and open technologies resonate better with configurations in which multiple values of technology practices are deemed important and supposed next to each other, instead of stacked on top of each other, with the most important one at the top.

The combination of these elements is what sets technologies of community-based innovation apart from seemingly similar technologies of market-based innovation. This finding is relevant because the characteristics of fluidity and openness are all about boundaries. As such they make visible the different arrangements of the boundaries between inclusion and exclusion, between inside and outside, between the sphere of production and the sphere of consumption, between makers and users.

[28] For the definition of free software, see Richard Stallman, founder of the GNU project (Stallman, 2002, 43), and widely recognized as one the pioneers of the free software and open source movement.

6.3 Different cultures of innovation

In the previous pages I discussed the phenomenon of community-based innovation, and during its exploration I discussed different types of work, unraveled the diversity of involved actors, and developed a vocabulary suited for community innovation. In a sense, the previous chapters jointly addressed the question of *how* community innovation matters. Now, nearing the end of this research-journey, I would like to address the question of *why* community innovation matters. In this concluding section I address that question by returning to the main aim of this dissertation: rendering visible the technology practices of community-based innovation by giving voice to the actors involved. The motivation behind this move is that community-based innovation is currently underexposed in dominant discourses on innovation, as articulated by 'common folks', members of the press, policy makers, business people and scholars and scientists in academia, rooted in common sense as well as theory-informed understandings.

In this concluding chapter I tried to describe what sets apart community innovation from other types of innovation. With this aim in mind, I presented a vocabulary capturing specific characteristics of community innovation. Not only did I argue that different words convey different meanings, but made the argument as well that the telling of different tales enabled plotting different heroes. In relation to community innovation, this implies that in my view, its protagonists should not be confined to a select elite of initiators, such as inventors and innovators, but include a wider range of non-professional actors as well, for it is within hybrid collectives where decentered arrangements emerge of alignment, domestication, care and coordination work.

My overall thesis is that we should aim at understanding the cultures of innovation in a broad sense, rather than restrict ourselves to an economics of innovation, which is currently the dominant meaning of innovation. Neglecting the broader societal values of community-based innovation results in a loss. A loss for science: lacking a detailed analysis of the diversity of technology practices involved in innovation. A loss for technology: lacking a broader and more inclusive understanding of different types of human-machine relations, and specifically those based on affective associations. And finally a loss for society: lacking policies to facilitating innovation along its full spectrum implies less ways to increase the societal values of innovations.

Broadening the analysis and conceptualization of innovation consists of including those actors and activities of innovation that remain invisible when innovation if only framed within its economic values. This enables us to enrich our understanding of the *full* dynamics of innovation, including types of work and actors. By introducing notions such as warm users and communification, I urged to take seriously metaphors such as 'adoption' (by care rather than consumption) or 'diffusion' (by osmosis rather than distribution) in their enriched meanings, not as afterthoughts to the innovation process, but as elements of intrinsic value. For what innovation is worth is something we can only assess by addressing values that go beyond the 'mere' economic value of innovation,

often quantitatively framed within the laws of the markets.

Currently the meaning of the word innovation has become inseparably intertwined with other words, such as market, economy, and growth. For sure, studying innovation framed within economics has its uses. However, we need to keep in mind that there is more to innovation than economics. Or in the words of Latour (1988, 203-204):

> "It is not a matter of economics. [...] Economics always arrives after the instruments of measurement have been put in place — instruments that make it possible to measure values and enter into exchanges.[...] Once the instrument of measurement is established, we can do economics and calculate, economize and save. In other words we can convince and enrich. But economists do not say how the instrument is established in the first place."

In addition to an economic understanding, I argue for a cultural understanding of innovation.[29] Especially in the case of value conflicts arising from the plurality of technology practices involved in community-based innovation, a cultural rather than strict economically framed analysis is more relevant in making visible all the values involved. Therefore, I urge to take serious the notion of the cultures of innovation, stressing its plurality. The first thing to stress is, when discussing innovation, we should emphasize that instead of a single, homogeneous 'Culture', there is a plurality of technology practices involved. So, instead of framing innovation in restricted terms of economics (without discussing how such a framing comes about and what it leaves out of the analysis), I propose to frame innovation broadly in terms of cultures.[30]

Cultures of innovation, instead of economics of innovation. The first reason why I make this argument explicitly has to do with how innovation is usually conceptualized within economics. By framing innovation as motor for economic growth, not all types of actors and activities involved are considered equally relevant and significant. For example, within an economic framing of innovation, exploitation is valued over experimentation. However, if we aim to cultivate innovation in its widest possible meaning, our focus should be on the plurality of locally situated cultures of innovation, rather than the single, increasingly trans-locally standardized economics of innovation. I sympathize with the aim of Innovation Studies scholars, who explicitly aim at not only studying innovation, but facilitating it as well. However, taking such an aim

[29] A concluding chapter is not the appropriate place for deconstructing culture as highly complicated and contested concept. Other authors provide book-length discussions of the notion culture, for example see Williams (1976).

[30] In the introduction to edited volume "The Cultures of Computing", Star (1995a) also mentions a second meaning of cultures, one that resonates with the term cultures in micro-biology colonies of bacteria. Instead of "cultures of innovation", I might as well haven chosen to discuss different 'regimes of innovation' (Callon et al., 2007) or different 'logic of innovation' (in the specific meaning as introduced by Mol (2006; 2008) in her book on the 'logic of care'). Nonetheless I decided for 'cultures of innovation', as this resonates nicely with Pacey's (1983) 'culture of technology' and Bijker's (1995a) term 'technological culture', however, adapting these notions by focusing on plurality and centering on the underlying process of innovation rather than technology emerging as outcome.

seriously, one should not unnecessarily restrict such facilitation of innovation to its economic value. Luckily, since von Hippel (1976) pioneering article on "users as sources of innovation", users have appeared on stage within Innovation Studies. Unfortunately, this turn to users, and more recently the turn to communities amongst students of innovation, is usually still framed within economics.

My second argument for putting the cultures of innovation central relates to enriching material-semiotic approaches on innovation. Seen from a material-semiotic perspective there is no essential difference between market-based innovation and community-based innovation. In this tradition, innovation is about the creation of novel actor-networks (and actor-worlds) that are stable and robust; irregardless if this activity is organized in a centralized or distributed fashion; if its initial protagonists are entrepreneur-innovators moved by profits or user-innovators moved by passions; if the resulting technologies are solid and closed, or fluid and permeable; or if users are configured as passive consumers or as active co-creators. Understood in such a basic theoretical sense, stripped of any normative evaluation, innovation is innovation. Within this approach all actors involved in the innovation are deemed equally important, whether an actor is user, producer, or even non-human. All well, one would think. In theory it is. In practice, however it is not. Scholars such as Bruno Latour (1987) or Madeleine Akrich (1992, 1995) state that the success of innovation is ultimately in the hands of its users, and thus grant users innovative agency. However, in their texts, one can still find a bias towards the design side of technology. Perhaps this asymmetry is an innocent side effect of an explicit focus on technology, which then leads these authors to follow its makers, instead of its users. Or if users appear, then in the role of actors involved in tales of failed of technology transfers (Akrich 1992). Even in the rich, detailed and highly nuanced account of a fluid technology, such as the Zimbabwe Bush Pump (de Laet 2000), the reader only gets to know what experts think matters, while voices of the villager-users remain silent.

In this research project I aimed to adhere to two principles. The first one was inspired by Innovation Studies: providing a better insight of innovation theories in order to facilitate innovation practices. The second one was inspired by a material-semiotic study of innovation: taking seriously *all* innovation actors, not only by stating why users are important, but also by studying how they are important. In my view, this PhD thesis has succeeded in keeping true to both principles. Distinguishing the different types of work involved in community innovation, accompanied with a vocabulary for capturing the specificity of community innovation, is the result, which hopefully diffuses further into innovation literature by infusing those involved in enacting innovation both in practice as well as in theory.

Despite a multitude of questions remaining without answer, swarms of illuminating case-stories suggesting further study and libraries full of relevant literature in need of further reading[31], I suggest what makes this single case

[31] Not claiming to provide a complete overview, I would nonetheless point to a selection of papers providing an overview of some relevant issues. For instance see von Hippel (2005a) for his claim

study thesis matter in the end, is how its approach of community innovation enables enriching the analysis of innovation in general. Strolling away from innovation captured within the territory of the market, I invite readers to wander with me on new paths, further exploring the fascinating landscapes of innovation by, for and within net-worked communities.

on the 'democratization of innovation'; Callon (2003) on 'research in the wild'; Callon (2003) on the 'increased involvement of concerned groups in R&D'; Callon et al., 2007 emphasizing the importance of attending to distributed, user-centered innovation on the policy level for a necessary 'reinventing innovation'; Latour (2003) on 'the world wide lab', or van Dijck and Nieborg (2007); van Dijck (2009); van Dijck and Nieborg (2009) for their critical assessment of 'wikinomics'.

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Appendix

Interviews

Ad Hofman, volunteer Wireless Leiden, 2008-08-01
Ans, non-user Wireless Leiden, 2008-07-07
Caroline Beijer, volunteer Wireless Leiden, 2005-12-08
Chris, home user Wireless Leiden, 2008-06-02
Evert Verduin, volunteer Wireless Leiden, 2006-03-27
Ger Koper, volunteer Wireless Leiden, 2008-07-24
Floris, home user Wireless Leiden, 2008-08-13
Henk Uittenbogaard, volunteer Wireless Leiden, 2008-07-28
Hugo Meiland, volunteer Wireless Leiden, 2008-07-29
Huub Schuurmans, volunteer Wireless Leiden, 2005-10-09
Igna, home user Wireless Leiden, 2006-02-23
Jan Janssen, radio amateur, 2006-02-22
Jasper Koolhaas, volunteer Wireless Leiden, 2005-10-25
Johan de Stigter, volunteer Wireless Leiden, 2005-12-06
Karen Sikkema, consultant Bureau Blaauwberg, 2006-11-23
Koos Riem, volunteer Wireless Leiden, 2008-08-12
Koos, non-user Wireless Leiden, 2008-08-13, 2008-08-14
Kornel van Doorn, student of Wireless Leiden, 2007-04-04
Lodewijk Vöge, volunteer Wireless Leiden, 2006-04-04
Marc van Munnen, volunteer Wireless Leiden, 2007-04-18
Mark Boos, volunteer Wireless Leiden, 2006-03-27
Marten Vijn, volunteer Wireless Leiden, 2005-10-14, 2006-07-11
Peter Poeliejoe, volunteer Wireless Leiden, 2005-11-03, 2008-05-08
Remco, non-user Wireless Leiden, 2008-08-14
Rene Hasekamp, volunteer Wireless Leiden, 2008-06-18
Rick van der Zwet, volunteer Wireless Leiden, 2008-08-08
Rob, home user Wireless Leiden, 2005-11-03
Rob van As, volunteer Wireless Leiden, 2008-07-23, 2008-07-28
Rudi van Drunen, volunteer Wireless Leiden, 2006-02-23
Suk-Jae Hummelen, journalist reporting on Wireless Leiden, 2008-12-12
Thomas van Praag, sponsor Wireless Leiden, 2008-07-29
Tom den Duijf, volunteer Wireless Leiden, 2008-07-01, 2008-08-07
Vic Hayes, chair IEEE working group 802.11, 2005-12-19

Observations

2005-03-06 open meeting Wireless Leiden
2005-07-29 What The Hack, hackers conference (Liempde, NL)
2005-10-09 open meeting Wireless Leiden
2005-11-03 technical meeting Wireless Leiden
2006-01-29 open meeting Wireless Leiden
2006-02-03 workshop Agentschap Telecom (Amersfoort, NL)
2006-02-11 open meeting Wireless Leiden
2006-03-22 'inloopspreekuur' Wireless Leiden
2006-04-30 open meeting Wireless Leiden
2006-08-02 Wireless Boot Camp (Oegstgeest, NL)
2006-12-09 Blaauwberg Workshop, Leiden
2007-04-19 open meeting Wireless Leiden
2008-06-02 'inloopspreekuur' Wireless Leiden
2007-11-29 conference Living Lab Leiden
2008-06-11 'inloopspreekuur' Wireless Leiden
2008-06-18 'inloopspreekuur' Wireless Leiden
2008-06-25 technical presentation Wireless Leiden
2008-06-25 participant observation Wireless Leiden
2008-07-01 participant observation Wireless Leiden
2008-07-02 participant observation Wireless Leiden
2008-07-29 participant observation Wireless Leiden
2008-08-01 participant observation Wireless Leiden
2008-08-04 participant observation Wireless Leiden
2008-08-05 participant observation Wireless Leiden
2008-08-07 Wireless Leiden board meeting, Leiden
2008-08-13 'inloopspreekuur' Wireless Leiden
2008-08-14 participant observation Wireless Leiden
2008-08-15 Open Community Camp (Oegstgeest, NL)

Illustrations

Most photographs were taken by the author himself during participant observation. However this is not the case in the following figures: 3.1 on page 57, 3.2 on page 61, 3.3 on page 62, 3.12 on page 90, 4.2 on page 105, 4.3 on page 111, 4.9 on page 118, 5.1 on page 131 and 5.2 on page 132. The source of these figures is the online Wireless Leiden SVN repository. These digital files have been made available under the Wireless Leiden License (http://svn.wirelessleiden.nl/svn/LICENSE.txt). The full license is reproduced here.

Publications

This thesis is partly based on previously published material. Parts of chapters 1 and 2 were published in *Science, Technology, & Human Values*, 34 (2009): 182–205; and in V. Hayes, and W. Lemstra, eds., *The Genesis of Wi-Fi* (Cambridge: Cambridge University Press, 2010), 263–287; both texts co-authored with E. van Oost and N. Oudshoorn, and the latter with Wolter Lemstra as well. Parts of chapter 4 appeared in *Observatorio (OBS*) Journal*, 3 (2007): 155–184; in B. Sapio et al, eds., *The Good, The Bad and The Unexpected: The user and the future of information and communication technologies* (Brussels: COST Office, 2008), 323–339; in J. Pierson, E. Mante-Meijer, and B. Sapio, eds., *Innovating for and by users*, (Brussels: COST Office, 2008), 133–144; and forthcoming as co-authored chapter with E. van Oost in T. Egyedi and D. Mehos, eds., *Inverse Infrastructures. Disrupting the System from Below* (Cheltenham: Edward Elgar, Forthcoming). Chapter 5 is partly based on work published in V. Frissen and J. de Mul, eds., *De draagbare lichtheid van het bestaan* (Kampen: Klement, 2008), 63–85.

Samenvatting

Het doel van dit proefschrift is op basis van empirisch onderzoek op het terrein van informatie- en communicatietechnologie een bijdrage te leveren aan theorievorming over innovatiepraktijken door gebruikers. Dat doe ik door innovatie door gebruikers vanuit een materieel-semiotisch perspectief te analyseren als gemeenschapsinnovatie. In dit proefschrift staat de vraag centraal hoe gemeenschapsinnovatie in de praktijk werkt.

Het eerste hoofdstuk vormt het vertrekpunt van het onderzoek met een literatuuroverzicht over de actieve rol van gebruikers in innovatie. Hierbij behandel ik literatuur uit Innovatiestudies en Wetenschaps- en Technologiestudies.

Innovatiestudieswetenschappers hebben vanaf de jaren 1970 gebruikers beschreven als belangrijke bron van innovatie. Aanvankelijk stonden hierbij gebruikers centraal in de vorm van professionele organisaties zoals bedrijven of wetenschappelijke instellingen. Pas vanaf de jaren 1990 was er aandacht voor gebruikers als individuele consumenten. De meest recente ontwikkeling is de focus gebruikerscollectieven als bron van innovatie. Expliciet doel van Innovatiestudies is de vraag hoe gebruikersinnovatie als katalysator kan dienen voor commerciële innovatie en economische groei. Dit economische kader heeft als logisch gevolg dat alles van niet-economische waarde naar de zijlijn schuift of buiten beeld valt. In tegenstelling tot deze aanpak, plaatst dit proefschrift niet-economisch gemotiveerde actoren en activiteiten niet in de marge, maar in het centrum van de analyse.

Deze benadering onderbouw ik met recente inzichten uit Wetenschaps- en Technologiestudies. Dit interdisciplinaire veld is gericht op de analyse van techno-wetenschappelijke innovatie als het construeren van nieuwe feiten en artefacten. Deze benadering onderstreept hierbij de actieve rol van non-professionele en onbetaalde actoren zoals leken, patiënten, burgers, consumenten en gebruikers. Consumenten en gebruikers zijn niet langer passieve ontvangers van innovatie, maar actieve mede-ontwikkelaars die uiteindelijk het verschil bepalen tussen succes en mislukking. Dit proefschrift volgt de materieel-semiotische aanpak van de translatiesociologie (ook wel actor-netwerk theorie) die innovatie analyseert als het assembleren van robuuste netwerken waarin zowel mensen als dingen actief zijn. Leidend voor het empirisch onderzoek is de focus op werk dat nodig is om deze netwerken op te bouwen, uit te breiden, te onderhouden en te coördineren.

De empirische basis van dit proefschrift bestaat uit een kwalitatieve, verkennende gevalstudie van het Nederlandse initiatief Wireless Leiden, als casus voor gelijksoortige initiatieven van innovatie door gebruikers van netwerken van informatie- en communicatietechnologie. Als innovatie op het gebied van openbare draadloze computernetwerken is Wireless Leiden in meerdere opzichten vernieuwend: de technische assemblage op basis van een nieuw gebruik van Wi-Fi technologie buitenshuis, de combinatie van bestaande en nieuwe open broncode programmatuur, en het organisatorische arrangement in de vorm van een niet-commerciële stichting met onbetaalde vrijwilligers. De keuze voor een enkele gevalstudie maakt een gedetailleerde analyse mogelijk van de verschillende typen actoren en werk dat van belang is voor innovatie door groepen gebruikers.

In hoofdstuk twee beschrijf ik de centrale rol van verbindingswerk (*alignment work*) voor het realiseren van innovatie door groepen gebruikers. In de gevalstudie Wireless Leiden gaat het hierbij om het opbouwen van een stadsdekkend draadloos netwerk door middel van het tactisch smeden van allianties tussen menselijke en niet-menselijke actoren. In de gevalstudie beschrijf ik hoe in Leiden een groep gebruikers interesse krijgt in de mogelijkheden van Wi-Fi voor het realiseren van een vrije communicatie-infrastructuur. Met behulp van het concept script beschrijf ik hoe de groep in Leiden opnieuw vorm geeft aan Wi-Fi; van technologie voor kleinschalig gebruik binnenshuis naar grootschalig gebruik buitenshuis. Het realiseren van deze Wi-Fi innovatie vindt plaats als collectieve onderneming.

Parallel aan de ontwikkeling van nieuwe technologie, ontstaan er ook nieuwe gebruikers. In de analyse onderscheid ik de organisatorische gebruiker als sponsor, de vrijwilliger-gebruiker, de thuisgebruiker, en de node-adoptie vrijwilliger. De aanwezigheid van een uitgebreid palet van kunde en kennis op gebieden van techniek, bestuur, recht en marketing, zijn een belangrijke hulpbron voor het oplossen van de vele puzzels voor verdere groei en stabilisering van Wireless Leiden.

De belangrijkste opbrengst van dit hoofdstuk is het concept gemeenschapsinnovatie (*community innovation*), waarbij de gemeenschap van gebruikers een onlosmakelijk onderdeel vormt van de innovatie als hybride collectief.

In het derde hoofdstuk staat domesticatiewerk (*domestication work*) centraal. Op basis van het concept domesticatie als het 'temmen van technologie', analyseer ik het werk dat in Wireless Leiden nodig is voor een verdere uitbreiding van het netwerk voor gebruik thuis. Op basis van de literatuur maak ik hierbij onderscheid tussen commodificatie, appropriatie en conversie als verschillende onderdelen van domesticatieprocessen.

Ten eerste beschrijf ik hoe de commodificatie van Wireless Leiden bestaat uit werk van de bouwers van het netwerk om Wireless Leiden te vertalen van vrij toegankelijke draadloze infrastructuur naar gratis draadloos internet. Het doel hiervan is om actoren te interesseren voor de rol van thuisgebruiker. Voor deze vertaalslag worden ook externe actoren ingezet, zoals het bedrijf

dat gratis toegang tot Internet sponsort, journalisten die over Wireless Leiden berichten als gratis en snel alternatief voor commerciële ADSL en kabeldiensten, en zoekmachine Google die Wireless Leiden presenteert als relevant resultaat voor Wi-Fi gerelateerde zoekopdrachten. Ook toekomstige thuisgebruikers verrichten inspanning voordat zij Wireless Leiden zien als aantrekkelijke optie voor Internettoegang. Zo informeren ze zichzelf over wat er wel niet mogelijk is, ze evalueren of het een aantrekkelijke en acceptabele optie is, en regelen de technische benodigdheden voor het opzetten van een verbinding.

Ten tweede beschrijf ik hoe door appropriatie Wireless Leiden zowel fysiek als symbolisch onderdeel wordt van een huishouden en het dagelijks leven. Appropriatie vereist niet alleen inspanning op het gebied van het disciplineren van radiogolven, maar ook onderhandelingen binnen het huishouden over Wi-Fi als nieuwe huisgenoot. Wat vooral opvalt is de hoeveelheid werk die thuisgebruikers besteden aan onderhandelingen met gezinsleden, familie of buren over de precieze plaatsing en configuratie van de benodigde technologie. Ook beschrijf ik hoe dit proces niet vanzelfsprekend succesvol is, maar soms leidt tot niet-gebruik.

Op de derde plaats beschrijf ik hoe door conversie het netwerk van Wireless Leiden zich niet alleen uitbreidt naar nieuwe gebruikers thuis, maar ook hoe in dit proces deze thuisgebruikers vervolgens onderdeel worden van het Wireless Leiden collectief. Hierdoor verandert zowel de identiteit van de thuisgebruiker als die van de gemeenschapsinnovatie. Voor deze beweging in omgekeerde richting introduceer ik het concept communificatie (*communification*) voor een beter begrip van domesticatiedynamieken van gemeenschapsinnovatie.

In hoofdstuk vier staat de rol van zorgwerk (*care work*) in gemeenschapsinnovatie centraal. Zodra zorg betrekking heeft op technologische artefacten wordt dit over het algemeen geclassificeerd als reparatie- of onderhoudswerk. In dit hoofdstuk laat ik echter de meerwaarde zien van een materieel-semiotische benadering waarin zowel mensen als dingen onderwerp van zorg zijn.

In de analyse van de gevalstudie Wireless Leiden onderscheid ik twee typen zorgwerk. De eerste vorm is gericht op 'zorgen voor technologie' (*caring for technology*). Dit werk valt te begrijpen vanuit affectieve hechting aan individuele objecten op basis van nabijheid, en vanuit reciprociteit voortkomend uit communificatie- en domesticatieprocessen. Het type actor dat hierbij betrokken is conceptualiseer ik als 'warme gebruiker' (*warm user*) om daarmee het affectieve karakter van de band tussen technologie en gebruiker te benadrukken.

De tweede vorm van zorgwerk is vooral gericht op 'geven om technologie' (*caring about technology*). Gemeenschapsinnovatie biedt een podium voor het vormgeven van identiteiten gebaseerd op technische expertise. Actoren geven zo vorm aan een mannelijke identiteit die gebaseerd is op intellectuele vermogens in plaats van fysieke kracht. Bij deze tweede vorm kenmerkt het zorgwerk zich vooral door creatief herontwerpen, in plaats van routinematig onderhoud.

Het hoofdstuk sluit af met de conclusie dat beide vormen van zorgwerk een intrinsiek onderdeel uitmaken van gemeenschapsinnovatie. Hiermee adresseert

zorgwerk als sensibiliserend concept een kennislacune binnen Innovatiestudies-literatuur ten aanzien van affectieve hechting tussen gebruikers en artefacten, en technologie als identiteitsproject voor gebruikers-innoveerders.

In hoofdstuk vijf staan de verschillende typen waarden van technologiepraktijken in gemeenschapsinnovatie centraal, mogelijke conflicten die hierdoor kunnen optreden, en het coördinatiewerk dat nodig is om hybride collectieven vervolgens bij elkaar te houden. Vertrekpunt voor de analyse van de empirie is de aanname dat er in technologiepraktijken sprake is van drie clusters van waarden, namelijk gebruikerswaarden, virtuositeitswaarden, en economische waarden. Tussen actoren die handelen vanuit verschillende waardenclusters kunnen conflicten ontstaan. Het oplossen daarvan vereist extra inspanningen die ik als coördinatiewerk beschouw. Uit de gevalstudie Wireless Leiden blijkt overigens dat in gemeenschapsinnovatie een vierde type waarden een belangrijke rol speelt, namelijk gemeenschapswaarden. Deze vinding is relevant omdat vooral de op coöperatie en exploratie gebaseerde gemeenschapswaarden lijken te botsen met op competitie en exploitatie gebaseerde economische waarden.

In de analyse van twee concrete conflicten in de gevalstudie Wireless Leiden, namelijk over commercialisering en professionalisering, onderscheid ik twee verschillende strategieën voor coördinatiewerk. De eerste strategie kenmerkt zich door de distributie van coördinatiewerk over de hele gemeenschap in combinatie met een horizontale ordening van de verschillende technologiepraktijken. Deze eerste strategie leidt tot omgekeerd grenzenwerk waarbij commerciële activiteiten buiten de gemeenschapsinnovatie geplaatst worden middels een proces van compartimentalisering van enerzijds het locale Wireless Leiden netwerk en anderzijds commerciële globale netwerken. De tweede strategie kenmerkt zich door een centralisering van coördinatiewerk gekoppeld aan een hiërarchische ordening van technologiepraktijken, met economische waarden als hoogste prioriteit. Onderdeel van deze strategie is translatering van gebruikers-, gemeenschaps- en virtuositeitswaarden naar economische waarden van gemeenschapsinnovatie om zo de inkapseling te faciliteren van het locale Wireless Leiden netwerk als node in globale netwerken. In de gevalstudie Wireless Leiden leidt deze strategie tot fragmentatie van de gemeenschap.

Onder de titel ‘innovatie herdenken’ benoem ik in het slothoofdstuk de opbrengst van dit proefschrift. Als eerste geef ik een samenvatting van de verschillende typen innovatiewerk die een rol spelen bij innovatie door gebruikerscollectieven; namelijk verbindingswerk, domesticatiewerk, zorgwerk en coördinatiewerk. Op basis van dit overzicht concludeer ik dat de gekozen focus op werk het mogelijk maakt om het complete spectrum van actoren die betrokken zijn bij innovatie in beeld te brengen. Niet alleen de gebruikelijke helden van innovatieverhalen zoals uitvinders en entrepreneurs, maar ook thuisgebruikers en technologische artefacten.

In het tweede deel van dit hoofdstuk reflecteer ik op de concepten die ik in dit proefschrift heb geïntroduceerd. Hierbij betoog ik dat de ontwikkeling van dit alternatieve innovatie-vocabulaire belangrijk is om gebruikers een pro-

minentere plaats te geven in theorievorming, onderzoek en governance van innovatie. Taal is niet neutraal, omdat de woorden die we hanteren bepalen hoe we de wereld om ons heen begrijpen. De introductie van nieuwe concepten maakt het mogelijk om stem te geven aan actoren die vorm geven aan gemeenschapsinnovatie, actoren die veelal afwezig zijn in het dominante discours over innovatie. Ook de technologische artefacten zelf dienen hierbij niet te ontbreken. Termen als vloeibare en open technologie wijzen op de karakteristieken van de technologische artefacten die gemeenschapsinnovatie faciliteren.

In het laatste deel van dit hoofdstuk pleit ik voor meer onderzoek naar de culturen van innovatie als tegenwicht voor de overwegend economische perspectieven op innovatie. Door de analyse en conceptualisering van innovatie te verbreden naar verschijningsvormen zoals innovatie door gebruikerscollectieven, ontstaat er een beter begrip van de gehele dynamiek van innovatie. Door termen als communificatie en warme gebruikers te introduceren pleit ik voor een verrijking van traditionele innovatiemetaforen zoals ‘diffusie’ (door osmose in plaats van distributie) en ‘adoptie’ (door zorg in plaats van consumptie). Door buiten economische kaders te denken, ontstaat een rijker uitzicht op de volledige waarde van innovatie.