To Gabriella and Sebastian

The more you know,
the less you understand.

When you have names and forms,
know that they are provisional

A good scientist has freed himself of concepts
and keeps his mind open to what is.

A Selective Assemblage from Dao De Jing by Lao Zi
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Ann-Christin
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I Gender, Technology & Women's Invention

This is a study with a simultaneous focus on gender and technology and in which women’s invention is used to problematize mainstream invention. Since both gender and technology can be seen as human constructs - both conceptually and materially - they can be deconstructed and reassembled in new ways. By reassembling the conceptual image of invention using building blocks related to both gender and technology I hope to challenge the limited understanding of invention that still seem to prevail.

Invention can be seen as a creative process which takes place both within human minds and in the real material world. The ideas of inventions are conceived within human minds but the problems they address are situated in the real world just as are the implementation of the solutions they result in. All ideas do not, however, become inventions. Most of us have ideas that we never realize due to lack of time, resources, knowledge, courage, energy etc. For an inventor thinking is not enough, invention takes some actual doing too. Hence, invention can be seen as an enacting of ideas or visions or scenarios that may bring some degree of change to the real material world - in other words innovation (see e.g. Akrich. 1992; Barker 1993).

The materiality of the real world is captured in the following quote: ”You know that we are living in a material world, and I am a material girl” (Madonna 1985, song: Material Girl, album: Like a Virgin). This quote from one of Madonna’s songs can be seen as ironic in relation to the human obsession with material things but, at the same time, it pinpoints an important aspect of human life on earth. As embodied beings we have our own materiality and the world we live in is very much a material world, consisting not only of nature but also of human-made artefacts like gender and technology.

Gender and Technology

An important aspect of our embodied materiality is gender (see e.g. Fausto-Sterling 1985 and 2000; Haraway 1991; Butler 1993). As in Madonna’s song I am a material girl, born in a female body and disciplined to fit into the category ‘woman’. I must admit that I have resented this disciplining and I doubt that I fit in very well, but then again - who does in practice? My reluctance to stay within the limited space prescribed for girls and women is probably one of the reasons why I came to study technology. But it is probably even more so the fact that I grew up believing there were no boundaries and that I could do anything I wanted which allowed me to make an unconventional choice. That I had an interest in creative activities like the production of art and other such things most certainly mattered too.
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An awareness that my choice to study technology was inappropriate came very much later, probably due to a naïve belief that I lived in a gender equal country and an insensitivity to disciplining signals. But these signals were not very clear either. Girls and women were encouraged to go into technology and efforts were made to attract more women (see e.g. Stanfors 2000; Svanståsson 2006; Fürst 1990; Salminen-Karlsson 1999:1 and 1999:2). However women who went into technology did not always feel welcome in its often male dominated culture (see e.g. Gunnarsson 1994; Fritz 1999). The signals women met were ambivalent. This is problematic since an interest which is affirmed becomes reinforced whereas one which is constantly undermined by uncertainty tends to erode and perhaps redirect itself towards less unstable ground.

My personal experiences from studying and working within the engineering sciences and within industry resulted in a wish to learn more about such matters. These were, for instance, why there were so few women within engineering or why industrial work was organized according to gender in ways that placed women in the least qualified positions and naturalized the reasons for limiting women’s access to and power over technology. Hence, I moved from engineering to the social sciences to pursue research on gender and technology.

The encounter with new theoretical perspectives on technology placed my personal experiences in contexts previously unknown to me. But instead of becoming a full blown social scientist I ended up as an academic hybrid with one foot in ‘gender’ and the other in ‘technology’ - a position which provides a particular point of view with both advantages and disadvantages. This is something I will return to in the final chapter.

As I began exploring feminist technology studies I learned about the often negative consequences of technology in the lives of women as users or workers in the production of technology (see e.g. Faulkner and Arnold 1985; Weisman 1992). I also learned about the working conditions of women within forms of education and professions related to the natural sciences or technology (see e.g. Granstam and Sani 1984; Kvande and Rasmussen 1990; Wahl 1992; Benckert and Staberg 1992; Trojer and Gulbrandsen 1996; Mörtberg, Christina 1997; Cockburn 1999). There were also studies of women’s sphere technologies or technologies of everyday life (see e.g. Hagberg 1986; Cronberg 1986; Norman 1988; Waldén 1990) and studies that questioned the emancipatory potential of technological change (see e.g. Nyberg 1989; Sundin 1992 and 1993; Pettersson 1996). Sometimes the actual doing of gender in contexts of technology was studied (see e.g. Vänje 2005). There were also studies with a focus on the actual doing of technology. There were studies of the history of technology in general (see e.g. Rydberg and Hult 1989; Nielsen, Nielsen, and Siggaard Jensen 1990)
and of women’s contributions in particular (see e.g. McGaw 1982 and 1997; Macdonald 1992, Stanley 1993; Englund 1993; Jansson 1996). There was a study about how the microwave oven was made that follows it through the gendered contexts of the innovation process (Cockburn and Ormrod 1993). There was also a study that addresses the question of what technology is based on examples of work that female engineering students and engineers actually do (Udén 1996 and 2000). That the understanding of technology in western culture has often come to be reduced to men’s artefacts, activities and fields of knowledge, makes the risk of excluding everything which is related to women obvious - something that has been in focus for feminist studies for a long time (see e.g. Rothschild ed. 1983; Wajcman 1991; Berner 1993).

On the other hand my encounter with science and technology studies taught me that they had a lot to say about society, technology and innovation (see e.g. Bijker, Hughes, and Pinch, 1987; MacKenzie and Wajcman 1999; Hackett, Amsterdamska, Lynch and Wajcman 2008) and that feminist science and technology studies also took gender into account (see e.g. Keller 1985 and 1995; Harding 1986; Haraway 1991; Bray 1997; Elovaara 2001 and 2004; Trojer 2002; Wajcman 2004; Barad 2007). That technology has become an integral part of society is reflected in concepts like ‘the sociotechnical’ or ‘the seamless web’ or ‘actor-networks’ or ‘apparatuses of bodily production’. Hence, the shaping of new technologies is simultaneously a shaping of the larger social systems of which they are part.

Definitions of the concept ‘technology’ are legio and vary from the very specific and limited to very broad and inclusive. (see also e.g. Nordin 1983; Lindqvist 1987). Technology can refer to material objects of use to humanity, such as machines, hardware or utensils, but can also encompass broader themes, including systems, methods of organization, and techniques. A very specific and limited definition of ‘technology’ and related concepts increases the risk of excluding important aspects.

In this thesis I have chosen to use the concept of technology in a broad sense referring to products, processes and related knowledge as well as to their organizational contexts. There are examples of others who have used the concept of ‘technics’ in this broad sense instead (e.g. Mumford 1986). I use the concept of invention to refer to the creative process through which new technologies are generated by developing ideas into something real that works well enough to be useful in practice. The degree of novelty does vary, however, and most inventions are variations of something already known rather than being radically new. Regardless of the degree of novelty inventions do not automatically become innovations but can bee seen as seeds of change. In this thesis the concept of innovation is used to refer not merely to the process
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through which an invention is turned into a commercial product but to the overall process through which an idea is developed into a product on the market. If successful, commercialized inventions may become integral parts of society and hence have an impact upon it. This however demands further development of the invention with production and economy in focus.

To sum up the theoretical perspectives that appealed most to me were perspectives that see gender and technology as being done by humans in interaction with other humans, ideas and materiality. These are perspectives that offer more inclusive understandings of how new technologies, as well as the relations needed for their realization, are achieved and hence recognize invention as a human rather than a male endeavour.

**Women’s Invention**

An inventor or an engineer is not expected to be a woman unless we explicitly say female inventor or female engineer, a paradox which may have to do with a cognitive habit that makes women within technology visible and invisible at the same time. We tend to see women as their gender whereas men are seen as humans (e.g. Fausto-Sterling 1985), in other words women become ‘the gender of gender’ and men ‘the gender of no gender’. Hence male dominated technology becomes symbolically related to men, the gender of no gender, making it unrelated to women, and gender, which could explain how this technology can be seen as gender neutral even though it is easy to find empirical evidence that it is not. Sharon Traweek (1988) has discussed this phenomenon in terms of ‘the culture of no culture’, which reflects an ideal of objectivity without sources of disorder like gender. Feminist scholars have challenged the notion of technology as neutral by exploring its organization and culture from a gender perspective and have found male dominance and masculine hegemony but also exceptional women. Hence, women’s invention can be seen as an exception to a masculine norm.

**Research Questions and Limitations**

To look at something well-known from a new perspective may unveil unknown aspects of the phenomenon and result in an alternative understanding of the subject that reveals openings for change (e.g. Haraway 1991). By focusing on women’s invention the exceptional is used to challenge a masculine norm that rarely acknowledges women as actors in relation to technology or recognizes women’s artefacts, activities and fields of knowledge as having anything to do with technology. Hence, women’s invention is chosen as the empirical foundation from which to assemble an alternative and more inclusive understanding of invention.
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In order to relate to the work of others I have searched for theoretical perspectives that allow all humans and not only men to be agents in relation to technology and allow technology to include the artefacts, activities and fields of knowledge of all humans - women included. In this search the concepts of ‘gender’ and ‘technology’ have emerged as central. These concepts can both be seen as ‘black boxes’ that we may study ‘in action’ when they are constituted and also as something to try to open up by studying controversies about their meanings (Latour 1987 and 1993). In this study it is the black box of technology - which often happens to coincide with that of masculinity - that is opened up letting women’s invention out into the open.

During the research process some themes emerged as particularly interesting to explore further. The major themes researched in this thesis are:

1. The origin and outcome of invention. To what extent do women invent? In what contexts does women’s invention take place? What characterizes women’s inventions?
2. The process of invention. How do new technologies come to exist? What do inventing women do and why do they do it? How do other people, things and knowledge become involved?
3. The gendering of invention. How is gender intertwined with technology in the culture and practice of invention? What problems and opportunities does this entail? What strategies do female inventors employ to succeed?

Even though the focus of this study is on invention issues related to the ensuing stages of the innovation process, such as production and commercialization, are sometimes touched upon since the subjects are closely related. The study builds upon empirical material about female inventors and their inventions. The inventors live in Sweden and work both within industry and also as entrepreneurs. Their inventions are both patented and unpatented but mostly have the character of a tangible thing.

Disposition of the Thesis

The thesis is organized as follows. In this the first chapter an introduction to the work at hand is given. In chapter two follows a presentation of methodological aspects of the study. In chapter three there is a discussion of theoretical perspectives on invention with particular focus on gender and technology. In chapter four quantitative data from patent registers is used to assemble broad images - contemporary and retrospective - of the origin and outcome of women’s invention. In chapters five, six and seven qualitative data from women’s narratives about invention is used to assemble more focused images that give examples of women’s invention in practice, to outline the process of
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invention, and to discuss the doing of gender and technology that takes place in relation to invention. The concluding chapter begins with a synthesizing discussion of the empirically grounded conceptual assemblages from the previous chapters thus outlining a tentative theory of invention. This is followed by summarizing discussions of the methodological insights gained and of possible paths to explore in future studies.
METHODOLOGY AND THEORY
II Considerations in the Research Process

The doing of empirical and/or theoretical studies and the writing about it can be seen as a way of taking part in the collective processes of knowledge production in the scientific community and of relating to the past and present work of others (Novotny, Scott, and Gibbons 2001). For PhD-students their studies in the field are often commenced while they are still learning about methodological issues which results in learning while doing. This implies a certain amount of trial and error in the process, but also the benefits of comparing research practise with theory with an emphasis on usability. This chapter contains reflections about methodological choices as well as about the research process in practice.

Methodological Influences

One of the major debates within feminist studies has been about whether or not there is a feminist science and feminist research methods. These were among the subjects that were discussed during the international conference ‘Feminist Research Methods’ that took place in February 2009 at Stockholm University. In practice there are many different kinds of feminisms - liberal, socialist, lesbian, postmodernist etc. - and feminist researchers often use a broad variety of methods that are not specifically feminist (see e.g. Gemzöe 2002). Despite this there are some guidelines that many feminist researchers follow. Methodologically this study has been influenced not only by feminist studies but also by ethnography and grounded theory.

Feminist Studies

Feminist studies have shown that knowledge about the world, the very basis for our understanding of it is often seriously biased. According to Simone de Beauvoir (1949) “Representation of the world, like the world itself, is the work of men; they describe it from their own point of view, which they confuse with the absolute truth.” Julie Nelson (1996) writes of objectivity that scientific practise is already full of subjective and contaminating influences - they just happen to be of an ‘androcentric’ variety and hence invisible to the majority of practitioners. Many feminist researchers have pointed out that the descriptions and explanations of nature and social life in science have been partial and distorted and with an emphasis on isolated traits and behaviours, linear relations and authoritarian models of order (e.g. Keller 1995). The feminist remedy has been to develop alternative perspectives, theoretical as well as methodological, hence contributing to more valid representations of the world. According to Harding (1991) one way of doing this is to contextualize what is studied and to take interactive relations as well as democratic models of order into
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consideration. Harding (1991 p. 307) claims that “feminism needs sciences that are more objective than the knowledge-seeking practises of androcentric, bourgeois groups in the West which have been passed off as objective, dispassionate, disinterested, universal science”.

In this study I have chosen to use women’s invention as an empirical foundation from which to problematize mainstream invention. “Thinking from women’s lives” is thus used to reinvent invention, to include the many rather than the elite few in analogy with the feminist project of reinventing science that Harding (1991 p. 312) formulates. The choice to focus on women is a way of highlighting them as actors with something to say about matters that have long been seen as a field of expertise for men. I have chosen to focus on women inventors although while a sample composed entirely of men is seen as unproblematic one composed entirely of women may be seen as odd, inadequate or perverse (Roberts 1981). If I had done a study of women and men comparisons between the sexes would inevitably have come into focus. But studies that compare women and men are always at risk of creating and reinforcing stereotypical images rather than problematizing such stereotypes, which was what I wanted to do. My choice has rather been to look upon women as human beings with diverse interests and experiences without necessarily pushing them into the feminine corner of the innovative arena. In order to do this I have chosen to study women’s invention - the process through which women contribute to the shaping of new technologies - and the contexts in which this takes place. The study has a simultaneous focus on gender and technology in order to capture their interrelatedness while at the same time avoiding a reproduction of conventional notions of either one; this is something that fits well with a technofeminist perspective (Wajcman 2004). According to Judy Wajcman feminisms share a concern with the hierarchical divisions between men and women that order the world we inhabit (Wajcman 2004). This gender ordering has often positioned men as inventors or designers of new technologies and women as responding to technologies that are already there. Wajcman sees attention to women’s concrete sociotechnical practises as one way of renegotiating the cultural equation between masculinity and technology. In this study it is women’s sociotechnical practice of invention that is attended to.

Ethnography

The manner in which data has been collected has to a large extent been influenced by multi-sited ethnography. George E. Marcus describes multi-sited ethnography as a development in ethnographic research influenced by postmodernism and arising from anthropology’s participation in a number of interdisciplinary arenas that have evolved since the 1980s: feminist studies and
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science and technology studies among others (Marcus 1995). Marcus exemplifies this approach with the work of Haraway and Latour (see e.g. Haraway 1991; Latour 1987). Marcus presents several different techniques through which multi-sited ethnographies’ objects of study can be defined; for example following the people, the thing, the metaphor, the plot, story or allegory, the life or biography or the conflict. Marcus describes the ‘follow the people’ technique as the most obvious and conventional mode of materializing a multi-sited ethnography. He describes the ‘follow the thing’ technique of following commodities, money, works of art, or intellectual property, for instance, as perhaps the most common approach to the ethnographic study of processes in the capitalist world system. In this study the approach has been to combine a following of people - female inventors - with a following of things - women’s inventions.

Grounded Theory

The collection of data has also been influenced by grounded theory (Glaser and Strauss 1967 and 2009). To carry out a study influenced by grounded theory implies a different relation to theory than in conventional studies where the empirical findings or ideas normally are discussed from a point of departure in existing theories - a kind of ‘top-down’ approach. The ‘grounded theory’ approach implies constructing new theories out of empirically grounded building blocks - a sort of ‘bottom-up’ approach. Instead of selecting a theoretical point of departure for the study theory is something that emerges out of the analyses of empirical data, of which existing theory is a part.

Grounded theory is achieved via a qualitative analysis which is not necessarily limited to qualitative data. The flexibility of grounded theory, which makes it suitable for this study, lies in the fact that any kind of data, qualitative as well as quantitative, can be made use of. I could of course have combined qualitative and quantitative data anyway. According to Karin Widerberg (2002) the combination of different kinds of methods, materials and analyses generally increases the quality of a study. She emphasizes the benefits of combining qualitative and quantitative research rather than doing just either or. I also found the bottom up approach of grounded theory, where a theoretical understanding is constructed out of empirically grounded building blocks, appealing since it resonates with my background in engineering, where experimental data are sometimes assembled into mathematical formulations of their relations. Furthermore I wanted my study to have a process perspective, which grounded theory could provide. I was also reluctant to force existing theoretical perspectives on to my empirical findings and wanted to see what the material had to say before I searched for theories that could contribute to the analysis. In that sense my study has been influenced by grounded theory even though it has
not explicitly followed its methodology from the outset. For instance the initial analysis was mostly of a thematic rather than a conceptual character and as my research questions have developed through a dialectic process they have to some extent been theoretically inspired. In other words, even though I was reluctant to force the empirical findings into a theoretical framework I still wanted to relate to existing theories, which through a kind of dialogical process led to a search for theoretical perspectives with as close a fit as possible. This is, an approach that I later learned fits well with a grounded theory approach. The theoretical findings have been treated as additional data which have been used in the construction of a theoretical understanding of the subject. Since this study is a synthesis of previous studies which have undergone similar analysis before, the search for and integration of theories with a fit has been an ongoing process during the various stages of analysis of the data. The search for and integration of existing theories can hence be seen as a reoccurring, iterative and dialectic process. The process of ‘grounded theory’ is hence both analytic and synthetic and results in theories that fit reality (Glaser and Strauss 2009). Grounded theory is generated through an analytical breaking down of knowledge into smaller pieces and recombining it in new ways. The synthesis may result in radically new ways of understanding different phenomena in society, something that may be labelled paradigm shifts or intellectual innovations. Like material innovations the intellectual ones, such as the attempts to construct empirically grounded theory in this study, are mostly of an incremental rather than a radical character.

In the analysis, the empirical material which this thesis builds upon was coded on a more detailed level than before and compared with the themes identified in previous analyses in searching for new insights. In the analysis of data I used some of the tools of constructivist grounded theory (Charmaz 2006). In the process of coding the words and actions of the respondents I used gerunds, which gives a strong sense of action and sequence and thus facilitates detection of processes. I followed the recommendations for coding with speed and spontaneity and for revising codes to improve their fit with the data. I used constant comparison of data, coding and ideas as a way of obtaining fit and relevance. Coding was done on different levels. Through the coding of interviews as entire narratives major themes were found and related to each other. Incident-by-incident coding was used to compare both similar and dissimilar events as well as to define subtle patterns and significant processes. In practice this has been a process whereby the empirical material has been coded, the codes have been transferred to post it notes, and the post it notes have been grouped and sequenced on large sheets of paper in search of clarifying patterns which have then been used to structure my reassembly of the empirical data.
Empirical Foundation

The empirical foundation of this study consists of data about women’s invention that has been collected through a process consisting of an initial explorative search followed by more substantial in-depth field work. The description of how these data were obtained, which aims to give an insight into the research process, builds on notes and documentations of past events as well as on memory work.

When I set out to study women’s invention an explorative approach was used since I had found previous studies with an explicit focus on this subject to be scarce (Nyberg 1999). In order to get an initial understanding of women’s invention I used ‘the snowball method’. Widerberg (2002) describes the snowball-method as a method where the person interviewed refers to other persons that may be interviewed. I started with interviewing some people who were familiar with female inventors or entrepreneurs in practice. These initial interviews lead to many different contexts, where further explorative interviews were carried out in order to map the terrain and to find directions for further explorations. Some of the people encountered had a lot of information to share whereas others turned out to know almost nothing about women’s invention. Sometimes these encounters gave access to other arenas of relevance for the study. Via the snowball method a multitude of actors and arenas related to invention were identified.

The Swedish Patent and Registration Office, founded in 1885, turned out to be a source of information about women’s patented invention. That no one had studied women’s invention in its patent registers motivated an in-depth study of this. The Swedish Inventors Organisation was founded in 1886 and is the oldest inventors’ association in the world. It has a network for women that gave me the opportunity to participate in activities where women inventors gathered and this enabled me not only to observe these events but also to come into contact with some informants for in-depth interviews (see e.g. Jonason 1999:1, 1991:2 and 2001). I also encountered informants via organizations such as the Swedish Agency for Economic and Regional Growth, the National Museum of Science and Technology, the Scandinavian Technical Fair and some large industrial companies with research and development in Sweden. The Swedish Agency for Economic and Regional Growth, that up until recently used to be called Nutek, had programmes focusing women’s entrepreneurship and innovations (see e.g. publications from Nutek 1992; 1996:1; 1996:2; 2000; 2001 and Stridh 2001). Information that was beneficial for the research process was also provided by a multitude of individuals, networks or organizations like e.g. the Women and
Technology Group, Innovative Women1, Imaginative Women in Norrbotten, SIC - Sweden Innovation Centre, and VINNOVA - The Swedish Governmental Agency for Innovation Systems. The Women and Technology Group, which consisted of women with an interest in technology as an important part of society, organized events on various themes related to women and technology (see e.g. Fritz 1999). Imaginative Women in Norrbotten is a regional inventors’ organization that was founded in 1999 and was the first inventors’ association for women to become a member of the Swedish Inventors’ Association. It originated from one of the many regional networks for innovative women which were formed in Sweden during the late 1990s through the project Innovative Women. Innovative women from the region, e.g. from the Arctic Inventors’ Network, became its members. The Sweden Innovation Centre, which was started as a government initiative to support inventors, financed advisors for inventors and the project Innovative Women (Piippola 2006).

Informal interviews and/or studies of documents were carried out with people encountered via these networks or organizations in order to map the terrain and find directions for further explorations. In some of these contexts more substantial fieldwork followed.

The explorative journey through the Swedish landscape in search of women’s invention can be seen as a kind of multi-sited ethnography in which the space of investigation was constructed by following female inventors and their inventions (see Marcus 1995). Following the inventors resulted in encounters with them as, for example, names in patent registers, members of the Swedish inventor’s associations, in various innovation related activities, entrepreneurs with firms of their own, employees of large industrial firms, and as actors in women’s narratives about their processes of innovation. Following the inventions resulted in encounters with these as classifications of inventions in patent registers, for example, or as representations like drawings or photos, exhibition objects, commercial products, and as ideas which were transformed into prototypes and/or products in inventors’ narratives about their innovation processes.

The main empirical material, which consists of both quantitative and qualitative data about women’s invention, was collected through partly overlapping and dialectic processes via a study of patent registers and interviews with female inventors. The study of women’s invention in patent registers was completed first and presented in my licentiate theses at Tema Technology and Social

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1 Innovative Women was a project that received funding from the Sweden Innovation Centre to establish regional networks for innovative women. As funding ceased, so did most of these networks (see Piippola S. 2006).
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Change at Linköping University (Nyberg 2001). The interview study was completed later and presented in a research report at the department of Industrial Economics and Organisation at the Royal Institute of Technology in Stockholm (Nyberg 2002). It is primarily the empirical material that was gathered during these studies in the late 1990’s and the early 2000’s which has been revisited, reorganized and reinterpreted in this thesis. Before moving on to the results of this remake I will provide a closer presentation of these two studies.

Women’s Invention in Patent Registers

The original purpose of the study of women’s invention in patent registers was to explore what could be found about female inventors and their inventions in the patent registers of the Swedish Patent and Registration Office. The patent registers are kept at the Patent Department of the Swedish Patent and Registration Office which is based in Stockholm. At the patent office I was told that most of the inventors in their registers were men and that there were approximately five percent women among the inventors. However, this fact was nothing that the patent office had documented in any way, nor could they refer to any documented study that showed this. General information about the patent office today, and in the past, in its information brochures and on its homepage was also of a gender neutral character and said nothing about male dominance among inventors.

I discussed the idea of doing a study of women’s invention in patent registers with personnel at the patent office who generously shared their knowledge about sources of information about female inventors, and their inventions, which contributed to the shaping of the study of patent registers. I was also given the opportunity to do much of the coding and processing of data on location at the patent office.

The patent office had registers in book form and in a computerized database. The registers in books were available in the patent office library. The computerized patent register was accessed with the aid of personnel at the department of information technology who provided information about the patents’ database and even the actual files that the study builds upon. The empirical material collected from these registers was limited to a Swedish context both in the sense that the inventors were living in Sweden and also to the public parts of the patent registers. Inventions of interest for the military were classified and hence could not be included in the study.

An initial problem to be overcome was that the patent registers contained no explicit information about the gender of the inventors. The Swedish patent office did not register social security numbers, or any other code by which gender could be determined. Only by analysing the first names of inventors could they be categorized according to gender. At first the discovery of an extensive use of initials in the registers seemed to make categorisation according to gender impossible. A closer study did, however, reveal two periods of time when the full names of inventors were registered. The register in book-form used full names from 1885 to 1929. From 1930 and forward the register in book-form used initials, as did the computerized register before 1991. The computerized register used full names during the period from 1991 to 1998.

**The Book Register: 1885 – 1929**

One of the patent registers studied was the patent register in book form. Register books covering the period from 1885 to 1990 were explored in search of female inventors. Inventors who were also applicants were found to have complete names recorded thus making gender distinguishable in the register books up until 1930, whereas the gender of inventors who were not applicants were obscured by the use of initials. All books from the period 1885 to 1929 were studied and women were noted as they were found, whereas men and the undefinable were excluded from the study. To include men in the study of the book-registers would have taken approximately 19 times as long, which would have exceeded the limitations of the study. The problem with undefinable first names was primarily a problem related to the computerized registers, not the book-registers. According to the personnel of the patent office library the use of initials becomes more frequent during the period from 1930 and forward thus making gender invisible for applicant-inventors too. This is something which was verified by exploring one book every tenth year in search of women.

**Sixty Years of Gender Blindness: 1930 – 1990**

It became clear that an extensive use of initials begun around 1930, which made it almost impossible to distinguish gender in the book registers. However, the full name of the inventor may very well be present in the application documents, the patent, or somewhere in the filed documents. To search for all the female inventors of the period from 1930 and forward in such documents would have meant studying extensive amounts of documents which are organized and filed in different ways. This would have been very time consuming and lain far outside the time frame of the research project.

The extensive use of initials then hides women - and men - among inventors in the sense that gender can no longer be distinguished via first names in the
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patent register. On the other hand, if a female inventor can be identified from other sources it is possible to find her in the patent registers too. One may be able to study a specific period in time too see if she was granted a patent. All the inventors whose inventions were never noticed by journalists - or others - are, however, at risk of remaining invisible due to the extensive use of initials in the patent registers. Testimonies from persons with knowledge of women’s inventions during this period might nonetheless be a way of highlighting female inventors in this prevailing darkness. There are most certainly many female inventors who could be lifted out of the invisibility that the use of initials in the patent registers have condemned them to. To make these women and their contributions to the technological development of our country visible is something that remains to be done.


The computerized register, or database of patents, is a product of computerization at the patent office. The computerized register offered an opportunity to include both women and men in the study. However, the register did not contain social security numbers or any other coding by which gender could be easily determined. Hence, gender had to be distinguished with the aid of the first name of the inventor in this register too. Up until 1990 the use of initials is so extensive that gender becomes obscured. Thereafter the use of initials decreases and the first names, and hence gender, becomes distinguishable. This allowed the large amount of data in the computerized register to be coded according to gender and subsequently processed, which was done on location at the patent office during the period from August to October 2000. In the coding process a book that contained amongst other things statistical information about the gender of the bearers of the 10 000 most common names in Sweden was used (Allén and Wåhlin 1995). If 95 % or more of the bearers of a name were of a specific gender, the name was coded accordingly. If not, it was considered undefinable. The first names of the inventors were coded as women, men or undefinable and women’s invention was compared to that of men whereas the undefinable were excluded. At the time of the study the patent applications from 1999 and forward had not yet been published. Hence the study was limited to the period from 1991 to 1998. The patent registers contained information about what had been invented, by whom, and in which context but said nothing about the actual process of invention. In order to find out how inventing actually was done other sources of information, like information obtained from interviews of inventors, had to be used.
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**Women’s Narratives about Invention**

The original purpose of interviewing female inventors was to find out more about the innovation process and to discuss it from a gender perspective. The empirical material which was collected via interviews thus became women’s narratives about their processes of innovation, invention included. Qualitative interviews can be used to capture the informants understanding of a specific theme, in this case the innovation process (see e.g. Widerberg 2002).

But before any interviews could be done the female inventors had to be found. The explorative journey through the innovative landscape led to many locations where female inventors exhibited their inventions or participated in invention related activities. Some of the informants for the interviews were identified via the Swedish Inventors’ Association, which is Sweden’s only national professional organisation for inventors with about 2500 members. These include individual members as well as companies ranging from active professional inventors to persons interested in the field of innovation. Founded in 1886 it is the oldest inventor’s association in the world. It is based in Stockholm and collaborates with about 40 regional inventors’ associations.³ The Swedish Inventors’ Association has a network for its female members, Female Inventors in Sweden, which organizes special activities and projects for female members.⁴ Imaginative Women in Norrbotten, which originated from one of the many regional networks for innovative women which were formed in Sweden during the late 1990s, was the first inventors’ association for women to become a member of the Swedish Inventors’ Association. Via the network for female members of the Swedish Inventors’ Association many female inventors were discovered. They came, primarily from the districts surrounding the larger cities of Sweden and from outside of industry. Imaginative Women in Norrbotten became a complementary source of information about women’s invention in the north, far from the centre of gravity constituted by the major cities of Sweden. Female inventors were also to be met at the Scandinavian Technical Fair which is one of the largest technical fairs in northern Europe. The Scandinavian Technical Fair takes place in October every year at Stockholmsmässan in Älvsjö, a southern suburb of Stockholm, and attracts numerous visitors. The National Museum of Science and Technology also offered opportunities for meeting female inventors. The museum, which was founded in 1924, is Sweden’s largest museum of technology with the responsibility for preserving


the national technological and industrial historical cultural heritage. It has also been the location for celebrations related to the International Women’s Day on the 8th of March. In order to celebrate women’s economic, political and social achievements the Women and Technology Group have organized many events at the museum. In 1982 female inventors participated, for the first time, in an event at the National Museum of Science and Technology which was entitled “Are there Female Inventors?” (see Löfgren 1982). In 1999 the Women and Technology Group celebrated its first 20 years with a retrospective exhibition, practical and creative projects, contests, entertainment and a seminar entitled ‘I believe I am a slumbering technological talent - Technology in girls’ ways’ (see Fritz 1999). These events provided temporary arenas where women, mostly, with an interest in technology gathered and this also gave female inventors an opportunity to present their inventions. Informants for the interviews were encountered during some of these events. These are some examples of how the inventors who were interviewed in this study were found.

Many Brief Interviews

The search process led me to many locations where a large number of female inventors were found and interviewed briefly. The interviewed inventors turned out to be entrepreneurs with small firms of their own rather than employees of industrial companies. The brief interviews resulted in many partial narratives about women’s entrepreneurial invention which, when summed up, indicated that ‘the inventor’ is a problematic concept and that far from all inventions are patented. Insights from these initial interviews also informed the design of the subsequent in depth interviews.

The lack of inventors from industry among the inventors initially interviewed in contrast with insights from the patent study - which showed that much of women’s patented invention takes place within industry - initiated a search for informants from within industry to interview. In order to get access to inventors within industry and permission to interview them I turned to the managers of the research and development departments of industrial companies which, according to the study of women’s patented invention, had many female inventors. However, finding female inventors within these companies turned out to be more difficult than anticipated. One possible explanation could be that the female inventors from the patent registers may have left the company or

6 Authors translation from Swedish
7 Authors translation from Swedish
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married and changed their family name. Another explanation could be that the managers wanted to find an informant who they believed would represent the company in a good way. Whatever the reason, the process of getting access to inventors via the companies and acceptance from the inventors for the interviews took very long time and gave a limited result. Eventually I did, however, get the opportunity to interview inventors from three large industrial companies that represent important sectors of the Swedish economy: a provider of telecommunication and data communication systems and related services, an automobile maker, and a provider of consumer goods and paper.

16 In-Depth Interviews

Thematic semi-structured in depth interviews concerning the innovation process and that identified with the subject were performed with inventors from within and outside of industry (Nyberg 2002 and 2003). Semi-structured and in-depth interviews that demonstrate solidarity are often used by feminist researchers (e.g. Gunnarsson 1994 and Udén 2000). An ambition was to initiate a respectful conversation with the informants about their innovation processes. The fact that I had a personal experience of being a woman within a male dominated context brought me closer to the experiences of my informants and was probably something that made it easier for them to relate to and trust me. Sometimes I actually felt that they provided information to me that was very personal and sensitive, making me feel a responsibility to handle this information with great care. Too seek information via interviews is a way of using people's wish to communicate about their lives to others. I found it easier than expected to get people to talk to me, perhaps because it is a rare thing to get the opportunity to talk about one’s experiences for hours with someone who is genuinely interested in listening. This highlights the fact that even if we strive to achieve an equal relation, this is difficult to achieve in the interview situation since it is always more or less asymmetric when it comes to power; it is the researcher who is in control.

Of course, insights into the innovation process could have been attained via observations too. To make observations of an entire innovation process ‘in action’ would have extended far beyond the timeframe of the project however. Hence, the in-depth interviews became a way of gaining insight into many long-term innovation processes.

The group of informants for the in depth interviews was made up of all the industrial inventors whom I got access to for an interview and of a selection of the inventors from outside of industry; these I refer to as entrepreneurial inventors in what follows. Four of the inventors had invented in an industrial context whereas twelve had pursued their inventive activities outside of industry, either within existing small firms or in start-ups of their own. The
industrial inventors had generally invented as part of a group but they had also sometimes invented individually. The entrepreneurial inventors had, on the other hand, generally invented individually but also sometimes within a small group.

Since the brief interviews indicated that not all inventions were patented, an ambition was to include both patented and unpatented inventions in the study. This was achieved and all of the industrial and almost half of the entrepreneurial inventors had Swedish patents for at least one invention. Some of the inventors who had patented inventions also had inventions that were not patented.

In the selection of informants an additional ambition was to include inventions that could be seen as technology in a conventional sense, i.e. be understood as masculine technology, as well as inventions somehow related to women and hence perhaps not self evidently regarded as technology. Nine of the inventors have inventions that specifically address problems related to women; of these some are related to women’s work and some to women’s bodies. The others have inventions without explicit focus on women’s problems.

With regard to the selection of informants, the ambition was also to include inventors of varying ages, with varying backgrounds from different parts of Sweden. The industrial inventors who became accessible for interviews were all born in the 1960s whereas the entrepreneurial inventors were born not only in the 1960s but also in the 1950s and 1940s. The informants have diverse educational and professional backgrounds including such professions as hospital orderly, nurse, midwife, art director, decorator, sculptor, researcher, programmer, engineer, chemist, restorer, project manager, accountant, controller, salesperson, shopkeeper, economist, human resources manager, public relations officer, special pedagogue, interpreter, politician, and physical education instructor. Since the patent study showed that women’s patented invention was concentrated to urban regions, I found it acceptable that most of the informants who agreed to participate in the in-depth interviews came from the regions surrounding the major Swedish cities Stockholm and Gothenburg and that only a few came from other regions.

The opportunities to gain access to and acceptance to participate from the informants came to have a great influence on the formation of the group of informants. It was relatively easy to get access to interview entrepreneurial inventors since they were free to make the choice to participate themselves. They were, however, often struggling to make a living as entrepreneurs, sometimes combining this with another job, which meant that their schedules often were very tight. Sometimes inventors opted out of participating in the interviews due to lack of time.
In order to facilitate participation in the interviews for the informants I often adapted to their busy agendas by letting them choose time and place for the interviews. Hence the interviews were performed in many different places - e.g. my office, their office, or public places like bars or cafes - something that sometimes made the quality of audio-recordings poor. Some interviews were recorded and others registered in hand notes only since I had to borrow audio recording equipment which was not always available. In order to compensate for this I worked through my notes as soon as possible after the interview when it was still fresh in my mind.

The initial in-depth interviews were relatively free and open ended in order to capture the inventors’ narratives about their processes of innovation without influencing them too much. The informants were asked to tell me about their processes of innovation, i.e. from how they got their idea to how it was developed into a functioning prototype or a product on the market. From their narratives recurring themes were discerned and questions added and as what was learned from previous interviews informed the following ones the interviews became successively more structured. Hence, the interviews can be seen as increasingly semi-structured and the resulting narratives became less alike.

The interviews tended to be much longer than anticipated. One reason was that it always took some time to create a trusting relationship by socializing and getting to know each other before the actual interview could start. Another reason was that once a rapport had been established the informants had very much that they wanted to share with me. On some occasions interviews were completed in another meeting or over the telephone since the informants were very busy and had many other activities on their agendas. Apart from the telephone, e-mail and letters were used in the interview related communication with the informants who were also given the opportunity to read and give feedback on what I had written. The in-depth interviews resulted in comprehensive narratives about the process of innovation, invention included, and the context in which it takes place. They gave access to the inventors’ reflections not only about the actual innovation process but also about experiences of discriminating practices in relation to it. They also described strategies to overcome such obstacles.

Some Ethical Considerations
The industrial inventors and their respective companies are presented under aliases whereas in some parts of the study the entrepreneurial inventors are presented under their own names while elsewhere they are anonymized. To make the industrial inventors and their respective companies visible would have limited the topics they could speak freely about since much of their work is
subject to secrecy. Their stories still differ from those of the entrepreneurial inventors in that they refer to the process of invention in general terms on a higher level of abstraction rather than to their work with specific inventions. The entrepreneurial inventors, on the other hand, refer to their work with specific inventions, something that makes it difficult to maintain their anonymity. During the research process it was agreed that they could be presented under their own names in relation to the parts which are about their specific inventions since they would be easy to recognize through their inventions anyway. Information less intertwined with the particular inventions or of a more sensitive character has however been anonymized for reasons of integrity.

**Approach to Theory**

Researchers are sometimes expected to come to the field of research without any theories in mind reminding of the idea of a child as a ‘tabula rasa’. But the tabula of the researcher is never empty but rather filled with all kind of inscriptions. Instead of hiding these inscriptions researchers must take them into account in order to achieve some kind of objectivity. According to Thomas S. Kuhn (1962) we must consider that all description is made from a point of view; an insight that has inspired the development of many concepts that aim for feminist objectivity, e.g. Evelyn Fox Keller’s concept of ‘dynamic objectivity’, Sandra Harding’s concept of ‘strong objectivity’, and Donna Haraway’s concept of ‘situated knowledges’ (Keller 1985; Harding 1986; Haraway 1991). Haraway proposes the use of ‘vision’ as a metaphor that is useful for avoiding binary opposition and insists on the embodied nature of all vision as opposed to the god-trick of seeing everything from nowhere or everywhere. Discarding both relativism and totalism as god-tricks she equals feminist objectivity with ‘situated knowledges’ where one way to go is to make our subjective positions visible and another is to make explicit our choices and uses of theoretical perspectives.

Using the metaphor ‘vision’ turns the theoretical perspectives into visual aids, into lenses that sharpen particular focuses. Like many others who do feminist technology studies I find myself using glasses which sharpens my understanding of gender as well as technology. By having access to both visual aids I may study my empirical findings through both, comparing what I see and what becomes invisible. I may even interchange or superimpose the lenses to see if something new appears, thus contributing to the development of a technofeminist lens.
III Selected Theories of Gender and/or Technology

In this chapter some theoretical perspectives that have gender and/or technology in focus, and that have contributed to the empirically grounded images of women’s invention that follow, are presented.

The simultaneous encounters with Donna Haraway (1991) and Bruno Latour (1993) revealed striking similarities in their perspectives on gender and technology that also fit well with my previous experiences from within the engineering sciences and led to further explorations of feminist studies as well as of science and technology studies.

By tracing the gendered roots of science in culture Haraway (1991) emphasizes that nature is constructed, not found. She problematizes the naturalization of race, sex and class by studying scientific research about the creation of nature, pointing out the emancipatory potential of phenomena that challenges established dualisms by using the concept of ‘the cyborg’ (Haraway 1991).

Latour suggests studies of ‘black boxed’ phenomena, like e.g. technology, ‘in action’ when they are constituted or of controversies about their meanings as keys to open them up (Latour 1987), and problematizes the dichotomic understanding of modern society (Latour 1993) claiming that we have never been modern in the sense of fitting well into these dichotomised categories, using the concept ‘hybrids’ to describe phenomena that refuses to stay in their prescribed dichotomised spaces.

The importance of over-bridging various dichotomies in order to achieve a humane and democratised technology ha been addressed by many. For example design is described in terms of a dialectics of tradition and transcendence (Ehn 1988). This could just as well be used to capture other processes of change like feminist change. That gender and technology can be understood in similar ways has led to a theorization of them as interrelated, mutually constitutive, co-constructed or co-produced (see e.g. Grint and Gill 1995) and debates about whether gender shapes technology or vice versa (see e.g. Sundin 1997).

According to these perspectives the shaping of gender as well as of technology is done in interplay between individual actors on the micro level and collective aggregates or structures on the macro level, giving different weight to actors and structures as determinants of their shaping. The outcome of such shaping processes can be of a preserving or a transformative character, but the creative dimension has often been underplayed in social theory (McNay 2000).

Understanding Reality

That both gender and technology can be seen as artefacts deepened my interest in two particular theoreticians, Hannah Arendt and Herbert Simon, who while
not easily labelled as belonging to any particular field still have a lot to say about the making of the human artifice.

Hannah Arendt (1906 – 1975) was a German political theorist who has been rediscovered by feminist scholars in recent years. Her most well known work ‘The Human Condition’, which was first published more than half a century ago, is about human action, the doing of the human artifice included (Arendt 1958 and 1998). Arendt explores the distinctions of the three human activities of labour, work, and action and describes the central theme of her book as being about “what we are doing” (Arendt 1998:5). She theorizes human doing in general, but also the specifics of doing technology.

Herbert Simon (1916 – 2001), was an American social scientist and a very productive polymath who has influenced science and technology studies through his writings about the human artifice and related creative processes. In 1978 he received the Nobel Prize in economics “for his pioneering research into the decision-making process within economic organizations”. In ‘The Science of the Artificial’, which was first published forty years ago, Simon states that the modern sciences, like engineering, has a problem handling that we live in an artificial world made of artefacts and emphasizes the need of a design oriented science of the artificial which makes it possible for research to contribute to the shaping of the good society (Simon 1969 and 1996). Simon suggests a design oriented science of the artificial as more fit to handle the aspects of transcendence and normativity in the shaping of often complex artefacts like technology or even the larger social context in which it is embedded.

Human understandings of the world we inhabit depend not only on our capabilities to sense the world and store information about it - sometimes by means of technological extensions - but also on the social contexts and cultural schemes that we have access to (Simon 1996, Haraway 1991). Hence, knowledges can be understood as situated (Haraway 1991). Cultural understandings of the world may refer to systems as well as processes, what we - human and non-human entities or aggregates thereof - are and what we do, what constitutes our identities and actions. Understandings that emphasize the notion of a static being have been challenged by perspectives where reality takes on more dynamic characteristics of doing (see e.g. Butler 1993; Barad 2007) resembling the ideas of the Greek philosopher Heraclitus of the world as constantly changing and fluid like a river.

According to Hannah Arendt a fundamental aspect of the human condition is that we are both products and producers of our circumstances in the sense that what humans do to some extent both depends on and alters the contexts in which this doing takes place (Arendt 1998), something actor-network theory refers to in terms of interaction between human actors and non-human actants as well as networks or assemblages of actors and actants (Akrich and Latour 1992; Latour 2005). The term situated action highlights the importance of the context (see e.g. Suchman 1987; Alonso and Simon 1993). There are also similar perspectives on the inter-dependencies of the observer and the observed within modern physics (Barad 2007). Karen Barad outlines an agential realism where agency is an enactment (see also Butler 1993), a matter of intra-acting, of making iterative changes to particular practices through the dynamics of intra-activity. Hence, reconfigurations of the real world come to matter through the dynamics of intra-action and the forces at work in the materialization of bodies are not only social just as the bodies produced are not only human (Barad 2007).

It is easy to sympathize with critique of determinist as well as relativist perspectives. If the theoretical perspectives on ‘gender’ and ‘technology’ are placed within a continuum reaching from determinism to relativism, the problematic rises as we approach the extremes. Determinism denies all other explanatory dimensions than the chosen one whereas relativism sees all explanations as equally valid. Radical social constructivism actually tends to forget its anti-determinist origin and sometimes approaches social determinism.

I found it troubling that no material core remained when the social layers were peeled off the onion, reducing the body and the world to abstract symbolic texts to read rather than parts of a concrete and tangible reality. Even though conceptual deconstruction may alter our understanding of reality a more hands on approach is needed if we want to change aspects of reality itself, which is actually the goal of invention - and of feminism and engineering design as well. If we want to know more about how human reality can be changed not only in theory but also in practice we must not forget the matter of matter. Hence, I realized that I had to find some way of hanging on to the material if I wanted to talk about invention in relation to gender and technology as phenomena in the real and not only the conceptual world.

The dilemma of loss of touch with the material has been noted and problematized within parts of feminist studies as well as within science and technology studies, where actor-network theory in particular sees technology as what makes society durable (Latour 1991). Within feminist studies research has strived to reclaim the body by problematizing the presumed nature given binary stability of biological sex (see e.g. Fausto-Sterling 1985 and 2000).
naturalization of sex has been problematized by tracing the gendered roots of science in culture, emphasizing that nature is constructed and not found (Haraway 1991) - in other words an artefact. Actor-network theory insists on symmetric analyses of human actors and non human actants - like technologies - taking material as well as semiotic aspects into consideration.

**The Shaping of Gender**

'Gender' often refers to the socially constructed differences between women and men whereas ‘sex’ refers to biological sex differences. When sociology appropriated the term ‘gender’ from grammar it was to enable the distinction to be made between biological sex differences and the differences between women and men that were seen as socially constructed (Oakley 1972, Cockburn and Ormrod 1993). One is not born a woman, one becomes it was how Simone de Beauvoir expressed it (de Beauvoir 1986). Many anthropological and sociological studies have demonstrated the wide cultural variation in notions and practices of gender difference and have analysed the processes in which gender is actively constructed (Cockburn and Ormrod 1993).

Gender has become a central concept in feminist studies, where society is generally described as being stratified according to gender both horizontally and vertically (Hirdman 1988, 1990 and 1993). Openings for change occur when women for different reasons have been able or forced to take the positions of men (Hirdman 1990). Even though constructivist feminist studies see gender as a human construct the ‘gender system’ (Hirdman 1993) perspective emphasises structural determinants whereas the ‘doing gender’ (West and Zimmerman 1987, Acker 1989) perspective emphasizes human agency and sees gender as performed, as something we constantly do in interaction.

The shaping or doing of gender takes place within dominant cultural understandings of gender as well as gendered practises of various kinds. Genderization of a society is shaped through cultural understandings of gender, through the gendered distribution of labour on all arenas, and through individual learning about and adaptation to - or challenge of - all this. These aspects of gender; also referred to as symbolic gender, structural gender and individual gender (Harding 1986); are described as mutually supportive in maintaining asymmetry and masculine dominance. Discrepancies and contradictions between these aspects over time are seen as openings for change (Harding 1986, Haraway 1991, Nelson 1996).

Gender is also seen as relational, which generally has meant relations between women and men. There has been a tendency to see gender issues as women’s issues but at the same time gender as relevant only in mixed sex contexts. Critique from postcolonial and gay/queer perspectives has emphasized the
differences in experiences within the groups of women and men. The understanding that gender is made in same sex contexts too means that it has relevance not only in mixed sex contexts but also in contexts dominated by either sex (see e.g. Berner and Mellström 1997) such as e.g. the often male dominated industrial research and development departments or care-giving organizations dominated by women. But even though the concept of gender in theory refers to both sexes, men are often self evidently seen as human whereas women are seen more as their sex than as humans (Fausto-Sterling 1985).

The Shaping of Technology

Even though technology is seen as a human construct within science and technology studies the ‘technological systems’ (Hughes 1987) perspective emphasizes structural determinants whereas ‘actor network theory’ (See e.g. Callon 1986) emphasizes human - and non-human - agency and sees the shaping of technology as performed. Within these perspectives focus is on innovation that takes place within stabilised ‘technological systems’ produced by system builders or within more fluid and flexible but still relatively convergent ‘actor networks’ that are constantly renegotiated.

The technological systems perspective builds upon the model of diffusion as a process started by an initial force and maintained via momentum. The actor network perspective builds upon the model of translation where no momentum exists and the initiating force is just like any other force. From this perspective one can never rely on actions in the past, the present has to be performed, over and over again.

From a technological systems perspective radical innovation is related to system building whereas innovation within existing technological systems is conservative. From an actor network perspective an idea is translated into an innovation by a network of interrelated actors that make up the heterogeneous ‘actor world’ (Callon 1986) that is necessary for constructing something. Through negotiations the network can be transformed into a ‘script’ or ‘scenario’ (Akrich 1992) seeking actors to play its roles, actors that also are networks, ‘actor-networks’. Strongly convergent networks take long investments, intense effort and coordination to achieve. Most networks are only weakly convergent and constantly threatened by conflicts and internal crises.

New translations (innovations) or challenges of existing translations take mobilisation and enrolment of new alliances. Actor network theory uses the concept ‘dynamic imbalance’ (Callon 1991) to describe the imbalance that occurs when one or more of the functionally related components lag behind, something the technological systems perspective refers to as a ‘reverse salient’
(Bijker, Hughes, Pinch (ed.) 1987). In a systems context most innovations are about solving problems with such imbalances.

**Gender and Technology as Artefacts**

The theoretical concept of technology refers to the human artifice but since humans often are understood as men and not women the meaning of technology hence becomes reduced to the male artifice. That technology is understood as related to men builds on an understanding of men and women as binary opposites where men are seen as technologically competent whereas women are seen as competent in care rather than technology. The interrelatedness of gender and technology has been theorized within feminist studies in terms of a mutual shaping where gender shapes technology and vice versa.

If we look on the shaping of gender through the glasses of the shaping of technology gender discrimination can be seen as a reverse salient or dynamic imbalance, an aspect of the system or network that lags behind, which may be addressed by innovation in order to improve the functionality of the system or network. From a systems perspective gender is hence shaped through a process started by an initial force and maintained via momentum - like sexism as a depressingly stable product of patriarchy or emancipation as an optimistically progressive product of enlightenment. From an actor network perspective on the other hand we can never rely on actions in the past, gender has to be performed, over and over again - just as from a doing gender perspective.

If on the other hand we look on the shaping of technology through the glasses of the shaping of gender cracks in the system or network like discrepancies between the symbolic understanding of technology, the structural organization of technology and the individual adaptation thereto can be seen as openings for change. The emphasis on actors or structures as determinants in the shaping of gender and technology may however not have to be a matter of either or. Perhaps the system perspective can be seen as being more valid in stable contexts where initiated processes can be expected to proceed without the continuous effort which is needed in the often uncertain circumstances of entrepreneurial endeavours in contemporary society.

**The Thing Character of the World**

Arendt emphasizes the materiality or the thing character of the world in which human activities takes place and discusses the impact of new technologies on human life exemplified by novelties in her time like the satellite and automation of industrial work (Arendt 1998). She sees humans as both producers and products of their conditions since the world human activities takes place in consists of things produced by human activities, things that in addition to the
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given conditions of nature in their turn condition their human makers. In Arendt’s theory about the making of things, like technology, agency is not a human prerogative, just as in the theories of Haraway and Latour.

In actor-network theory about the shaping of technology agency includes both human agency and the agency of non-human actors - actants - and of aggregates of actors/actants - actor networks. According to Haraway ‘objects’ studied have to be granted the status of agent/actor, a ‘material-semiotic actor’ who is not necessarily human (Haraway 1991). Hence the world becomes an active entity no longer objectified as a resource or raw material available for human projects, as a thing, but rather as a coding trickster with whom we must learn to converse (Haraway 1991).

Neither does Simon restrict creative agency to humans alone (Simon 1996). Much of Simon’s writing is actually about the creative agency of artificial intelligences. “We are importing and exporting from one intellectual discipline to another ideas about how a serially organized information-processing system like a human being - or a computer, or a complex of men and women and computers in organized cooperation - solves problems and achieves goals in outer environments of great complexity” (Simon 1996 p. 138).

Arendt emphasizes that action, speech and thought must undergo materialization, be transformed into things, in order to remain in the world beyond the remembrance of those who have witnessed them and that they rely on the same workmanship that builds other things in the human artifice. According to Arendt the reality and reliability of the human world rest primarily on the fact that we are surrounded by things more permanent than the activity by which they were produced, and potentially even more permanent than the lives of their authors. Arendt’s own work is an example of human thought that through its materialization as a book has remained in the world beyond the lifetime of its author.

**The Making of Things**

Arendt distinguishes the work of our hands from the labour of our bodies (Arendt 1998). She sees work as the bringing durable use objects into the world which ends when the object is finished and labour as the cyclic lifelong struggle to survive through the production of consumer goods. She sees the human artifice with its variety of things as fabricated through work. These things are mostly, but not exclusively, durable objects for use that are not immediately consumed when used properly but that eventually become used up or decay. Arendt sees such durable things as having the function of stabilizing human life. She sees the distinction between labour and work as a difference in degree depending on the worldly character of the produced thing - its location,
function, and length of stay in the world. According to Arendt it is the products of work - and not the products of labour - that guarantee the permanence and durability without which a world would not be possible at all. This resembles Latour’s understanding of technology as society made durable (Latour 1991). The least durable of tangible things Arendt sees as those needed for the life process itself, the products of labour whose consumption barely survives the act of their production.

Arendt describes the work of fabrication as guided by a model in accordance with which the object is constructed. The model which precedes fabrication can be an image beheld by the eye of the mind or be tentatively materialized as a blueprint. The model, which does not disappear with the finished product, can be used for continued fabrication, for multiplication, for mass production. Hence many perishable objects can be made according to such a model. The process of making ends when an entirely new thing - an invention in other words - with enough durability to remain in the world as an independent entity has been added to the human artifice.

According to Arendt the making of things is repeated when the craftsman needs to earn his means of subsistence or when the market signals a demand for multiplication, hence adding the art of earning money to his craft (Arendt 1998). Here she describes how the inventor becomes an entrepreneur and how the things that are made change character. When manufacturing is done for the market it produces exchange objects rather than things of utility. Today we discuss the diffusion of new products on the market in terms of innovation.

Creativity

Simon has written numerous articles on the subject of creativity within various fields. He argues that there are great commonalities among the creative processes, wherever they appear. According to Simon (1983) a psychological theory of creativity or discovery or invention would account for the processes that are involved in bringing about novel and valuable products. Based on a survey of literature on creativity Simon summarises that creative thinking is characterized by (1) willingness to accept vaguely defined problem statements and gradually to structure them, (2) continuing preoccupation with problems over considerable periods of time, and (3) extensive background knowledge in relevant and potentially relevant areas.

Simon (1983) emphasizes the need to also take insight based on recognition into account, even though little is known about how recognition occurs. According to Simon the ability to achieve sudden insights into situations by recognizing familiar features in them depends on having stored a great deal of knowledge. To have stored knowledge about existing ways of solving various
problems in ones memory may of course be very useful. Women do however often lack such storages of knowledge when it comes to technological problems (Aurell 2000).

According to Simon (1983) problems that call for creativity are problems from domains that have not already been well worked over and in which sophisticated, systematic algorithms for solution do not exist. Hence, the less is done the more creative opportunity there is. He claims that such problems have to be addressed using weak methods, like e.g. generate-and-test (trial-and-error search) and means-end analysis, that require larger or smaller amounts of search before problem solutions are found and generally use rules of thumb to avoid having to search the entire space.

**Problem Solving**

According to Simon human behaviour reflects the real world and information about it which is stored in books and in the long-term memory (Simon 1996). The human problem solver relates to an outer environment consisting of the ‘real’ world as sensed and acted upon and a large store of information about the world, correct as well as incorrect, held in our long-term memory - our inner library of skill and knowledge - and retrievable by recognition or association. Sudden flashes of ‘intuition’ - like those inventors often describe - are hence acts of recognition. The external environments of thought, the real world and long term memory, undergo continual change. Memory is adaptive, it updates and adds. Simon sees no difference between learning things already known to others and things new to the world. The making of discoveries he sees as is ill-structured problem solving with ill-defined goals.

Human problem solving involves varying mixtures of trial and error with selectivity through some kind of feedback of information from the environment. Simon identifies two basic kinds of selectivity based on information about stable configurations that become building blocks for further construction or on previous experience, where the latter corresponds to reproduction. Complex hierarchic systems will evolve from simple systems much more rapidly if there are stable intermediate forms than if there are not.

Simon (1996) sees complexity as a key characteristic of the world we live in and of the systems that cohabit our world and gives a rough definition of complex systems as made up of a large number of parts that have many interactions. Based on examples from various disciplines he discusses complex systems and concludes that a large proportion of them are hierarchical - consisting of interrelated but not necessarily subordinate subsystems - something that makes them easier to understand and describe.
Human information-processing capacity limits the number of people simultaneously involved in most forms of social interaction like i.e. the enacting of the role of a friend or the carrying on of a conversation, with mass communication as an exception. Simon finds it probable that social systems share characteristics of physical systems where higher-frequency dynamics are associated with the subsystems and lower-frequency dynamics with the larger systems exemplifying with the less frequent interactions of longer duration and the longer planning horizons at the higher levels of an organizational hierarchy as well as stronger intracomponent than intercomponent linkages.

Simon acknowledges the dilemma of “whether we are able to understand the world because it is hierarchic or whether it appears hierarchic because those aspects of it which are not elude our understanding and observation” (Simon, 1996).

According to Simon problem solving can be seen as change in representation, making evident what was previously obscure, making the solution transparent (Simon 1996). Such representations may be a picture on paper or a three-dimensional model but also the representation inside the head of the designer or the memory of a computer. Search processes may be viewed not only as processes for seeking problem solution but also more generally as processes for gathering information about problem structure that will ultimately be valuable in discovering a problem solution. Simon suggests that complex systems might be expected to be constructed in a hierarchy of levels, or in a boxes-within-boxes form. According to Simon a powerful technique to design such a complex structure is to find ways of decomposing it into semi-independent components corresponding to its functional parts, allowing each component to be designed with some degree of independence of the design of others. It is the function that matters, not how it is achieved in detail. Problem-solving systems and design procedures in the real world do not merely assemble problem solutions from components but must search for appropriate assemblies by exploring several tentative paths, following the most promising paths and maybe exchanging the less promising paths for other ones during the process.

The design process can be seen as involving both the generation of alternatives and the testing of these alternatives against an array of requirements and constraints. A building designed from the outside in will differ from one built from the inside out resulting in desirable variants - as long as they are within the limits of satisfactory constraints - rather than alternatives to be evaluated as “better” or “worse”. Variety makes it possible to attach value to the search as well as its outcome, to regard the design process as a valued activity for those who participate in it.
Comparisons between designs in terms of “better” and “worse” can be used to find satisfactory solutions rather than the “best” one - something Simon has introduced the term ‘satisficing’ for (Simon 1996:119). In the real world we rarely have a method for finding the optimum which means we have to settle for a satisfactory solution. Satisficing is done by looking for alternatives in such a way that an acceptable solution can be found after moderate search.

**Man the Maker**

According to Arendt the human artifice is created by ‘homo faber’, man the maker, who she sees as the master of himself and his doings as opposed to those who engage in labour which is governed by necessity and action which always depends on others (Arendt 1998). She describes the work of homo faber as solitary work aiming at excellence, and hence not really suited for teamwork. She sees the division of labour in production as a process of deskilling and teamwork as organized the same way.

From a contemporary perspective homo faber’s work of bringing material things into the world appears as strangely atomistic considering that Arendt otherwise always insist on action as taking place in relation to others, that action is interaction. The hands on bringing of material things into the world appears more as something an expert does best in solitude without being interrupted by others, perhaps as a result of how Arendt perceived organization of industrial work in her time. That Arendt refers to homo faber as ‘him’ reflects the fact that few women were involved in the shaping of new technologies through invention in her time as well as today (see e.g. MacDonald 1992 and Stanley 1993).

Simon on the other hand talks about man the maker in terms of designers who are not only engineers but everyone who devises courses of action aimed at changing existing situations into preferred ones, inventors included (Simon 1996). This is a very inclusive definition by which feminists too can bee seen as designers. Like Arendt Simon too sees human action as interaction and our ability to reach our goals as tightly linked to our interactions with others in our society.

**Woman the Maker**

Man has however not always been the maker of things. From a historical perspective Arendt describes how the freedom of free men in ancient Greece was the freedom from labour and work, from activities concerned with necessity or utility, a freedom which was used to engage in the public life in the city-state, reflect on or speak with other free men about things beyond necessity or use or just simply enjoy the pleasures of life (Arendt 1998). The human
activities concerned with necessity and use were of course of great importance for human life but had according to Arendt been made the concern of those who were not free: slaves, foreigners, women and children in the private sphere of the household. This gives an interesting image of invention in ancient time as a concern of women and other others rather than of free men.

There are some studies of women makers of technology that use information from patent registers to make women’s forgotten inventions visible (e.g. Pursell 1981, Amram 1984, Moussa 1986 and 1991, Vare and Ptacek 1988 and 1993, Sender Beauchamp and McDaniel 1990, Merritt 1991, Macdonald 1992, Stanley 1993, and U.S. PTO 1999). These studies show that the percentage of women among inventors generally is low but that there still are many women who invent within a broad range of fields. I did not find any documented study of Swedish women’s patented invention. Hence I decided to do a study myself (Nyberg 2001).

Some studies also reflect on qualitative aspects of women’s invention. The limited invention of women and its canalization to particular fields is explained in terms of differences in living and working conditions between women and men due to prejudice and discrimination. Historically women have lacked many basic human rights, like economic rights and cultural attitudes towards female inventors have been restrictive and condescending (Cummins, McDaniel, Sender Beauchamp 1990, Merrit 1991, Wajcman 1991). Many of women’s inventions were hence patented by men (Amram and Morgan 1980, Wajcman 1991, Stanley 1993). Women’s limited invention reflects their limited rights and possibilities to make decisions concerning themselves or their ideas and products, which they for long had no right to call their own (Amram 1984, Wajcman 1991, Stanley 1993). Women have also had limited access to education in mathematics, mechanics and engineering which has been the basis for many inventions and innovations (Amram and Morgan 1980; Amram 1984; Wajcman 1991). Formal knowledge is however not enough; inventors also need practical experience (Wajcman 1991). Women’s creativity has often been canalized to the private sphere of the household or to art, music, writing or cooking whereas real inventions were seen as weapons, machines, and chemical substances created in laboratories (Wajcman 1991, Stanley 1993). Inventions reflect the context of the inventor who has access to the problems and develops an expertise about previous technology and use of materials. Women invent within the fields in which they are active (Stanley 1993). Women’s inventions reflect their role in the family and on the labour market, the division of labour and the genderization of different kinds of technology (Rothschild 1983; Schützsack 1995). As women have gained access to education, laboratories and economic positions the limits of their creativity have decreased. Still, women generally don’t work with the development of new product ideas.
METHODOLOGY AND THEORY

Out of the explicit studies of women’s invention emerged an image with focus on the extent to which women have invented, what they have invented, and the wider social context in which they have invented but not very much about how invention actually is done. To conclude the explicit studies of women’s invention discussed the origin and the result of invention whereas the process in between remained a ‘black box’.

Hybrids and Cyborgs

Latour (1987) suggests studies of ‘black boxed’ phenomena like e.g. technology ‘in action’ when they are constituted or of controversies about their meanings as keys to open them up, and problematizes the dichotomic understanding of modern society claiming that “we have never been modern” in the sense of fitting well into these dichotomised categories. He uses the concept ‘hybrids’ to describe phenomena that refuse to stay in their prescribed dicothomized spaces (Latour 1993). Haraway points out the emancipatory potential of phenomena such as ‘the cyborg’ that challenges established dualisms (Haraway 1991). Apart from ‘the cyborg’ Haraway’s ‘FemaleMan©’ incorporates the - unfortunately - still quite radical claim of feminism that women are people and refuses to stay within the ‘black box’ labelled ‘woman’ (Haraway 1997).

The discussion about the hybrid nature of various phenomena questions the borders of identity by recognizing our interrelatedness with others, humans as well as non-humans, expanding us to include the fluid and flexible networks of people and things through which we act. Who am ‘I’ without my family and colleagues, my clothes and glasses, my books and my computer, the production and distribution of electricity etc - the network of people and things and aggregates thereof which enables my present thoughts and actions? From such a perspective ‘I’ am no longer a disconnected atomic entity moving freely in the world but rather entangled in a web of interactive relations who may be enrolled to intra-act as one (see Barad 2007).

The perspectives I found most useful see both gender and technology as artefacts created by humans in interaction with other humans and with the world, the real one as well as the one of ideas. Perspectives on the shaping of technology - invention included - have shifted focus from independent individual creators to an interactive shaping of ‘the socio-technical’ - a material-semiotic aggregate of humans and non-humans. I see this as a destabilizing move beyond the conceptual labels on the ‘black boxes’ right into their complex content. In order to understand the generation - production and reproduction - of bodies and other objects of value Haraway introduces ‘the apparatus of bodily production’ through which objects and their boundaries are materialized in social interaction (Haraway 1991). Hence, such an ‘apparatus of bodily production’ or an ‘actor-network’ (Latour 2005) can bee seen as what
enables us to interact with and change not only our surroundings but also our material selves - in other words to shape artefacts like gender and technology.

My detours into the theoretical realm have given me travelling companions on the explorative journey through the empirical world, companions whose perspectives have enriched my perception thereof. Now it’s time to move on to a number of images from the explorative journey that I, sometimes assisted by my companions from theory, have assembled out of encountered empirical data about women’s invention.
EMPIRICAL ASSEMBLAGES
IV Women’s Invention in Patent Registers

“There have been very learned women as there have been women warriors, but there have never been women inventors” (Voltaire as cited in Merrit 1991). The quote above comes from the French enlightenment philosopher Voltaire (1694 – 1778), who we today can conclude was not as enlightened in the matter as one might expect. What has proved him wrong is information about women’s invention in patent registers.

A review of previous research revealed that patent registers provide the only systematic documentation of invention (Nyberg 1999). The fact that no previous study of Swedish women’s invention in patent registers had been documented was among that which motivated me to do such a study (Nyberg 2001).

This chapter is the result of a qualitative analysis of quantitative data from patent registers where the patterns discerned from the material are of primary interest rather than the exact figures, even though some figures are presented too. The research questions that emerged in dialogue with the studied material have to do with the origin and outcome of women’s invention in terms of its extent, context and character - questions that could be answered by studying individualized patents in the patent registers.

A Retrospective Image: 1885 – 1929

One of the periods that turned out to be available for study was the years from 1885 until 1929, a period about a century ago. The image of women’s invention during this period is assembled out of data from the patent register in books of the Swedish Patent and Registration office. As mentioned before it was only the inventors who also were applicants that were named by first names in the book register and hence possible to study. Before going into the questions about the origin and outcome of women’s invention during this period it is the actual extent of it which is chosen as focus.

Five Patents per Year and Almost Four Percent

What could data from the patent register in books reveal about the extent of women’s invention about a century ago? Were there any female inventors? If so, what did they invent? When processed the data shows that a total of 163

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9 Merrit refers to Voltaire, 3 Oeuvres Complètes 98 (new ed. 1879) and also present the quote in French “On a vu des femmes très savants comme il en fut de guerrières; mais il n’y en jamais eu d’inventrices”.

43
women are named as applicant-inventors in 206 or 3.7% of the 5524 patents for the period from 1885 to 1929, see table 1.

<table>
<thead>
<tr>
<th>Period</th>
<th>All patents</th>
<th>Women’s patents</th>
<th>Women’s percentage of patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885 – 1889</td>
<td>186</td>
<td>6</td>
<td>3.2</td>
</tr>
<tr>
<td>1890 – 1899</td>
<td>664</td>
<td>19</td>
<td>2.9</td>
</tr>
<tr>
<td>1900 – 1909</td>
<td>1352</td>
<td>49</td>
<td>3.6</td>
</tr>
<tr>
<td>1910 – 1919</td>
<td>1648</td>
<td>88</td>
<td>5.3</td>
</tr>
<tr>
<td>1920 – 1929</td>
<td>1674</td>
<td>44</td>
<td>2.6</td>
</tr>
<tr>
<td>1885 – 1929</td>
<td>Σ = 5524</td>
<td>Σ = 206</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Table 1 Absolute and relative numbers of women’s patents for the period from 1885 to 1929

Table 1 shows the total number of patents (PRV 1967) as well as the number and percentage of patents with women as applicant-inventors for the period. Note that the patents by female applicant-inventors are not individualized in this table in order to make them comparable with the total number of patents retrieved from another source (PRV 1967). Individualization of the patents does however only increase the number of patents by female applicant inventors to 209 instead of 206.

When it comes to the number of patents there were in average five patents per year with women as applicant-inventors during this period. The maximum number of 12 patents occurred in 1911. The percentage relative to men of women’s patented inventions was just below four percent during the whole period from 1885 to 1929 and it reached a maximum just above five percent during the period from 1910 to 1919. The number of patents with women as applicant-inventors increases until the 1910th decade and declines thereafter, probably due to the increased use of initials during these years.

Data revealed that most female inventors during this period have only one patent. The distribution of the 163 female applicant-inventors according to the number of patents for the period from 1885 to 1929 is shown in table 2.

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10 Note that the figures initially are presented for a five year period and then for ten year periods.
Table 2  Number and percentage of female inventors according to number of patents for the period from 1885 to 1929

Table 2 shows that 133 female applicant-inventors or 82% had only one patent, 21 or 13% had two patents, and only 9 or 5% had three or more patents. The average number of patents per woman was 1.3. At most two women applicant-inventors had 6 patents each.

The image that emerges reveals that there were female inventors during this period of time but that they were few relative to men. This was something that actually had been noted by the chief engineer at the patent office during the last decades of the 19th century, Salomon August Andrée (Andrée 1888). Research from other countries provides similar images of women’s invention during this period (see e.g. Stanley 1993; U.S. PTO 1999). Having learned that women actually invented during this period of time, even though there were few women relative to men among the inventors who actually patented their inventions, focus is now shifted towards the contexts from which women’s invention originated.

Mostly Individuals Outside of Organizations

What could data from the patent register in books reveal about the contexts from which women’s invention originated about a century ago? To begin with the patent register contains information about where the inventors lived. The distribution of patents with women applicant-inventors according to domicile is shown in table 3 for the period from 1885 to 1929.
Table 3 shows that almost half of the patents have applicant-inventors from Stockholm and even more if places like Lidingö and Saltsjöbaden are included in Stockholm. The other patents have applicant-inventors spread all over the country, though often in more urban areas like Gothenburg and Västerås. Out of this assembly of figures emerges an image of women’s invention as sprung out of rural as well as urban regions. During this period women did not have the mobility away from the home and into the elite as men had (Berner 1996). This makes it reasonable to assume that women’s inventive work probably took place close to where they lived.

No female inventors could be found in patents owned by organizations since their first names were hidden behind initials in the patent registers during this period. Since women did not get access to higher technical education, which was intended for a male elite, until 1921 and technical work was considered unsuitable for women there were very few women within the world of technology during the late 19th and early 20th century (Berner 1996). This makes it reasonable to assume that female inventors within industry probably were few and exceptional. The image that emerges is hence an image of women’s invention as something that normally took place outside of industrial organizations even though there may have been some exceptions.

Whether female inventors invented as part of a group or alone could also be determined via the patent register. The distribution of patents in which women are named as applicant-inventors according to the size of the group of inventors of the patent in question is shown in table 4 for the period 1885 - 1929.
Table 4 shows that most patents with female applicant-inventors have only one inventor. In 17 of the 209 patents with female applicant-inventors the applicant-inventors consist of groups of two persons, where women were paired up with a man in 13 cases and with another woman in four cases. Only in three patents do the applicant-inventors consist of groups of three persons. One of these groups consists of two women and one man and the other group of two men and one woman. None of the groups of which women are part consist of more than three persons.

Having learned that women during this period most often invented alone outside of organizational contexts and that at least half of women’s invention took place in the Stockholm region, but that women also invented in many less populated parts of Sweden too, focus is shifted towards the outcome of their inventive activities.

**Mostly but Not Exclusively Women’s Sphere Inventions**

What could data from the patent register in books reveal about what women invented about a century ago? The patent register in books contains limited information about the inventions which were patented and unfortunately none or inconsistent coding of their character. Initially no coding of the inventions was used. When coding of the inventions was introduced it varied from year to year making comparisons over time difficult. An overall image of what women patented during this period can however still be assembled out of descriptive information from the respective patents.

Many inventions from this period were contraptions for cocking combined with sources of heating like for example tiled stoves and different kinds of burners. Many inventions also had to do with the preservation or preparation of different kinds of food. Many inventions were about facilitating the work of washing and cleaning, like e.g. machines for washing the dishes or doing the laundry or cleaning. Many inventions were different kinds of furniture, often multifunctional and collapsible or transformable. Quite a few inventions had to do
with clothes, care of the clothes, sewing, and personal hygiene. Some inventions had to do with the work of caring and nursing or were of a pedagogical character. But women applicant-inventors did also have inventions that have to do with e.g. chemistry, vehicles, security devices, and weapons.

Many of women’s inventions from this period can be seen as related to the domestic sphere. This reflects that the home was seen as women’s place during this period (Berner 1996). Sometimes women’s inventions were related to professions that were open to women (Sommestad 1987 and 1992). There were however also patents with women as applicant-inventors from many other fields of technology. Some women actually invented weapons. This was however nothing new. Already in 1774 mademoiselle Maria Christina Bruhn presented water- and fireproof ammunition of her own make to the Swedish Science Academy (Lönnroth 1991). Women’s invention during the period may hence be seen as primarily but not exclusively related to the women’s sphere. Women’s inventions from the period are never the less quite diverse and encompass everything from washing machines to machine guns.

We have learned that the women who invented during this period were few relative to men and that they most often invented alone outside of organizational contexts, often in the Stockholm region but also in many less populated parts of Sweden, and that their inventions primarily but not exclusively were related to the women’s sphere. From here focus is shifted towards the obscurity of the following sixty years.

**A Missing Image: 1930 – 1990**

For the period from 1930 to 1990 neither women nor men could be identified in the patent registers due to an extensive use of initials instead of full first names. Hence, the image of women’s invention during this period is a missing one still waiting to be unveiled. This could perhaps be done by studying other patent documents in search of the first names of the inventors. It would however be a time-consuming task since these documents have to be retrieved from where they are filed and studied manually.

Another way to go is to make an estimate of how many women who are hidden behind initials in the patent register. If we assume that women kept on inventing during this period of 60 years to the same extent as they had done before, which was in average five patent per year, about 300 female inventors would be hidden behind initials in the patent register. If we assume that women’s invention increased, the hidden female inventors would be even more numerous. That there would be no female inventors at all during this period does seem unlikely.
There are also ways of finding female inventors despite the use of initials. If a female inventor is identified via other sources she can be identified in the patent register.

An Example of What Initials Can Hide

An example of a very productive inventor from this period is Ninni Maria Kronberg who invented and patented eleven inventions between 1930 and 1964. As I learned about her existence it was possible to search the register books and find her patents even though she is only present as N. M. Kronberg. Her inventions have to do with improvements of doughs and flour, dried milk, additives to delicatessen, glue and forage for kettle\footnote{The patents of Ninni Maria Kronberg have the following numbers: 69730, 82451, 85344, 85916, 87636, 96765, 100810, 110612, 113074, 115194 and 116329.}. The patents reveal that she lived in Rydsgård and that Svenska Mjölkprodukter AB in Stockholm, who later became Semper, are the applicants and hence owners of her patent of dried milk.

Svenska Mjölkprodukter AB based their initial activity on the production of dried milk, which Semper AB describes the following way\footnote{\url{http://www.semper.se/templates/page.aspx?id=17 2009-10-07.}}. The company Svenska Mjölkprodukter AB is founded by Doctor Axel Wenner-Gren in 1938 and in 1939 production starts in the first Swedish milk powder plant in Kimstad. The coincidence in time of the start of the company and the application for and granting of the patent of dried milk with Ninni Maria Kronberg as inventor indicates that her invention may have contributed to the establishment of the company Svenska Mjölkprodukter AB, today known as Semper AB. Ninni Maria Kronberg is only one example of a woman hidden behind initials in patent registers. There are most certainly others like her.


The other period during which gender could be discerned in the patent registers via the inventors’ first names was the years from 1991 until 1998, a period in the very recent past which is here considered to be contemporary. The image of women’s invention during this period is assembled out of data from the computerized patent register of the Swedish Patent and Registration office.

Ninety Patents per Year and Just Above Four Percent

What can data from the computerized patent register reveal about the extent of women’s invention about a decade ago? When processed the data shows that a
total of 512 women are named as inventors in 716 or 4.3 % of the 16800 patents for the period from 1991 to 1998, see table 5\textsuperscript{a}.

<table>
<thead>
<tr>
<th>Period</th>
<th>All patents</th>
<th>Women’s patents</th>
<th>Women’s percentage of patents</th>
</tr>
</thead>
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</tr>
<tr>
<td>1993</td>
<td>2 211</td>
<td>79</td>
<td>3.6</td>
</tr>
<tr>
<td>1994</td>
<td>2 358</td>
<td>92</td>
<td>3.9</td>
</tr>
<tr>
<td>1995</td>
<td>2 492</td>
<td>105</td>
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</tr>
<tr>
<td>1996</td>
<td>2 949</td>
<td>143</td>
<td>4.8</td>
</tr>
<tr>
<td>1997</td>
<td>2 702</td>
<td>122</td>
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<tr>
<td>1998</td>
<td>1 690</td>
<td>87</td>
<td>5.1</td>
</tr>
<tr>
<td>1991 – 1998</td>
<td>$\Sigma = 16 800$</td>
<td>$\Sigma = 716$</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Table 5 Absolute and relative numbers of women’s patents for the period from 1991 to 1998

Table 5 shows the total number of patents as well as the number and percentage of patents with women as inventors for the period. Note that patents here refer to individualized patents.

When it comes to the number of patents there were in average 90 patents per year with women as inventors during this period. The maximum number of 143 patents occurred in 1996. The number of patents with women as inventors increased until 1996 and declined thereafter, probably due to that some of the applications from these years still were going through the patenting process waiting for the patent to be granted when the study was done in 2000.

The percentage relative to men of women’s patented inventions was just above four percent during the whole period from 1991 to 1998 and it reached a maximum just above five percent in 1998. The low percentage of women among inventors in Sweden is something that has been noticed by others (Jansson, I. 1996; Jonasson, M. 1999; Moussa, F. 1986).

Data revealed that most female inventors during this period had only one patent. The distribution of the 512 female inventors according to the number of patents for the period from 1991 to 1998 is shown in table 6.

\footnote{Note that the figures are presented annually.}
EMPIRICAL ASSEMBLAGES

<table>
<thead>
<tr>
<th>Number of patents</th>
<th>Number of female inventors</th>
<th>Percentage of female inventors</th>
</tr>
</thead>
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<tr>
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<tr>
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</tbody>
</table>

\[ \Sigma = 512 \quad \Sigma = 100 \]

Table 6  Number and percentage of female inventors according to number of patents for the period from 1991 to 1998

Table 6 shows that 412 female inventors, just above 80 percent, had only one patent whereas almost 20 percent or approximately one out of five female inventors had more than one patent, implying a reoccurring inventive activity. The average number of patents per woman was 1.4. At most one woman had 17 patents.

Having learned that even though women’s invention has increased compared to a century ago when seen to the number of patents the percentage still remains low, focus is shifted towards the contexts from which women’s invention originated during this period.

**Mostly but Not Exclusively Industrial Teamwork**

The computerized patent register also contains information about the context of women’s invention which reveals variations according to geography, organization and gender.

The geographic dimension of the context of invention could be discerned via the domicile of the inventors. For the period from 1991 to 1998 information about where the female inventors lived was translated into a county code. The distribution of patents with women inventors according to county is shown in table 7 for the period from 1991 to 1998.
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<table>
<thead>
<tr>
<th>County</th>
<th>Number of patents by women</th>
<th>Percentage of patents by women</th>
</tr>
</thead>
<tbody>
<tr>
<td>No county</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Stockholm county</td>
<td>173</td>
<td>24.2</td>
</tr>
<tr>
<td>Skåne county</td>
<td>66</td>
<td>9.2</td>
</tr>
<tr>
<td>Västra Götaland county</td>
<td>227</td>
<td>31.7</td>
</tr>
<tr>
<td>Västernorrland county</td>
<td>41</td>
<td>5.7</td>
</tr>
<tr>
<td>All other counties</td>
<td>206</td>
<td>28.8</td>
</tr>
<tr>
<td><strong>Sweden</strong></td>
<td><strong>Σ = 716</strong></td>
<td><strong>Σ = 100</strong></td>
</tr>
</tbody>
</table>

Table 7  Number and percentage of patents by women according to county for the period from 1991 to 1998

Table 7 shows that about one fourth of women’s patents have inventors from Stockholm County, where the Capital of Sweden is located. Here we find the ‘silicon valley’ of Sweden and women have many patents related to the patent class ‘Electricity’ of which electrical communication technology is a significant part. Stockholm County also have many other industries like e.g. vehicles and pharmaceuticals with patents by women. There are also quite a lot of patents by inventors outside of industry.

Almost one third of women’s patents have inventors from Västra Götaland County which includes the second largest city in Sweden, Gothenburg. In Västra Götaland we find patents by women within e.g. the hygiene, the automobile and the chemical industries. Most of women’s patented invention in Västra Götaland County is related to the class ‘Human Necessities’, of which hygiene is an important subsection.

Almost one tenth of women’s patents have inventors from Skåne County, where the third largest city of Sweden Malmoe is situated. Like Västra Götaland County Skåne County is also dominated by patents within the class ‘Human Necessities’, but here by inventions related to the food industry.

Hence, almost two thirds of women’s patented invention takes place within the three counties of Stockholm, Västra Götaland and Skåne. Almost half of Sweden’s population is concentrated to these counties where the three largest cities in Sweden are located. Women’s invention does however also take place within less populated regions than those surrounding the three major cities. Apart from Västernorrland County, where the inventors of almost six percent of women’s patents live, each of the other counties house inventors of less than five percent of the patents. Women in the forest rich counties of Värmland and Västernorrland have patents within the class ‘Textiles; Paper’. Women in the counties of Östergötland, Västmanland, and Norrbotten have patents within the
class ‘Electricity’. A few women in Örebro County, where Alfred Nobel once lived and worked, have patents related to the munitions industry.

Out of the assembled data emerges an image of women’s invention as most often sprung out of urban regions where people and organizations are found that may be of importance as actors in the process.

The computerized patent register also contains information about who, in terms of individuals and organizations, is the applicant for and hence the owner of a patent. For the nation as a whole and the entire period from 1991 to 1998 two dominant categories of applicants, and hence owners of patents, can be distinguished. About 80 % of the patents are owned by some organizational owner, generally an industrial company, whereas the remaining 20 % are owned by the inventor herself.

Unfortunately the patent register says nothing about how the inventors are related to these owner organizations but for legal reasons it is close at hand to make the assumption that they are employed at the research and development departments of these companies (see SFS 1949:345¹⁴). A telephone survey with managers of the research and development departments of some of the companies with most patents was done in 2002 and it confirmed that this is generally the case. Patents which are owned by an organization generally refer to invention done within the organization. The inventors named in patents owned by these firms are generally employed at their research and development departments. There are cases when the inventor is a consultant contracted by the company or a patent is bought from an independent inventor, but this is very unusual. Hence the assumption that the patent register reveals in which organizational contexts invention takes place seems reasonable to make.

The industrial companies with most patents by women are Svenska Cellulosa AB SCA followed by Ericsson, Asea Brown Bowery, Telia/Televerket and Sandvik. Companies like the munitions manufacturer Bofors have patents by women too, even though not so many. Name-changes in the computerized patent register due to reorganizations or mergers as well as incomplete names complicate the image. An example is the state-owned Televerket that changed name to Telia when it was privatized in 1993.

Out of the assembled data emerges an image of women’s invention as something that mostly, with some exceptions though, is owned by and hence takes place within industrial contexts.

¹⁴ Lag (1949:345) om rätten till arbetstagares uppfinningar
The computerized patent register also contains information which makes it possible to distinguish if an inventor has invented solo or as part of a group of inventors. The distribution of patents in which women are named as inventors according to the size of the group of inventors of the patent in question is shown in table 8 for the period from 1991 to 1998.

<table>
<thead>
<tr>
<th>Group Size</th>
<th>Number of patents by women</th>
<th>Percentage of patents by women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>161</td>
<td>22.5</td>
</tr>
<tr>
<td>2</td>
<td>193</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>132</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>15</td>
</tr>
<tr>
<td>≥ 5</td>
<td>125</td>
<td>17.5</td>
</tr>
</tbody>
</table>

\[ \Sigma = 716 \]

Table 8 shows that almost a quarter of women’s patents have solo inventors whereas more than three quarters of women’s patents have two or more inventors. Hence, most female inventors have invented as part of a group. Women are generally part of gender mixed groups whereas men generally are part of all male groups, a difference possible due to the low percentage of women among inventors. Groups with only women are uncommon and do not exceed four persons in size. The largest group of which women are part consists of 23 persons whereof eight are women.

Out of the assembled data emerges an image of women’s invention as something that most often takes place within gender mixed groups whereas only a smaller part is done by an individual inventor alone or within a group consisting only of women.

**Mostly but Not Exclusively Industrial Inventions**

What could data from the computerized patent register reveal about what women invented about a decade ago? The information about what women actually invented during the years from 1991 until 1998 is available in the computerized patent register as a code. The inventions are coded according to the International Patent Classification, also known as IPC.

Women’s patents distributed according to IPC are shown in table 9 for the period from 1991 to 1998.
Table 9 shows that a little more than a third of women’s patents belong to the IPC class ‘Human Necessities’ (A). But even though this is the largest IPC class when it comes to women’s patents, most of the patents in this class still have men as inventors. Most of women’s patents within IPC class A, 72%, belong to its subsection ‘Health; Entertainment’ whereas only a small part, 13%, belong to the subsection ‘Personal or Household Articles’. Most of women’s patents within the subsection ‘Health; Entertainment’, 99%, belong to yet another subsection ‘Medicine and Veterinary Science; Hygiene’. Within this subsection there are no patents by women concerning veterinary science. Hygiene on the other hand constitutes a significant part. The class A61F constitute 56% of the subsection ‘Health; entertainment’. In this subsection hygiene articles like hygiene pads and baby diapers can be found. In other words this subsection consists of inventions related to medical science and hygiene.

That about a fourth of women’s patents, 27%, are related to medical science and hygiene is not surprising considering that many women are educated and/or work within health and care. These inventions are however owned by private

<table>
<thead>
<tr>
<th>IPC Class Code</th>
<th>IPC Key</th>
<th>Number of patents by women</th>
<th>Percentage of all patents by women</th>
<th>Women’s percentage in each class</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Human Necessities</td>
<td>271</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>Performing Operations; Transporting</td>
<td>79</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Chemistry; Metallurgy</td>
<td>92</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>D</td>
<td>Textiles; Paper</td>
<td>64</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>E</td>
<td>Fixed Constructions</td>
<td>20</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>F</td>
<td>Mechanical Engineering</td>
<td>24</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>G</td>
<td>Physics</td>
<td>59</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>H</td>
<td>Electricity</td>
<td>107</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

\[ \Sigma = 716 \quad \Sigma = 100 \quad 4.3 \]
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companies or by the inventors themselves rather than by the public county councils or hospitals.

The IPC class ‘Electricity’ (H) comes on second place with 15 % of women’s patents. Within IPC class ‘Electricity about half of the patents belong to the subsection ‘Electric Communication Technology’ and a little more than a third belongs to the subsection ‘Basic Electric Components’. The IPC class ‘Chemistry; Metallurgy’ (C) comes on third place with 13 % of the patents. This reflects the fact that electro-technology, chemistry and metallurgy were among the fields that first were opened up for women (Berner 1996).

The IPC class ‘Performing Operations; Transporting’ (B) encompasses 11 % of women’s patents and is followed by ‘Textiles; Paper’ (D) with 9 % and ‘Physics’ (G) with 8 %. The IPC classes ‘Fixed Constructions’ (E) and ‘Mechanical Engineering’ (F) comes last with 3 % of the patents each. This reflects that it took the core subjects of engineering, like mechanical engineering, longer to open up to women (Berner 1996).

The largest group of women’s contemporary patents were classed as ‘Human Necessities’ followed by ‘Electricity’ and ‘Chemistry; Metallurgy’. Even though ‘Human Necessities’ constituted the largest group, most of women’s patents actually had to do with conventional technology. There were for instance many patents related to information and communication technologies as well as to new materials. Inventions that had to do with textiles, personal or household articles which are often seen as related to the women’s sphere were on the other hand just as uncommon as inventions related to weapons and nuclear physics.

Change and Status Quo

The image of invention which has been assembled out of data from the patent registers reveals that some aspects of invention has changed during the last century whereas others remain surprisingly stable.

The patent registers give us not only a minimum figure of how many female inventors there have been in Sweden but also the number and percentage relative to men of their patented inventions, se table 10.
Table 10  Female inventors, patents by women and the percentage relative to men of women’s patents

From 1885 to 1929 a total of 163 women are named as applicant-inventors in 206 or 3.7% of the patents. From 1991 to 1998 a total of 512 women are named as inventors in 716 or 4.3% of the patents. During the whole period studied, 1885 – 1998, a total of 675 women are named as inventors in 922 or 4.1% of the patents. Data from the patent registers reveal that there have been at least 675 female inventors in Sweden between 1885 and 1998.

A comparison of the average annual number of women’s patents and the percentage relative to men is shown in table 11.

Table 11  Comparisons between the studied periods of the total number of patents by women, the average annual number of patents by women and the percentage of patents by women relative to patents by men

Table 11 shows that there has been a great increase when it comes to the number of patents of female inventors if the period from 1885 to 1929 is compared with the period from 1991 to 1998, something that reflects a general increase of patented invention. From 1885 to 1929 there are in average five patents per year compared to 90 patents per year during the 1990s. The percentage relative to men does however remain almost the same. Even though many more women patent their inventions in the late 20th century than they did a century before they are still a minority relative to men.

A comparison with studies of women’s patented invention in other countries reveals low percentages as well, e.g. 5.7% in the US 1977-1996 (US PTO
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1999)\textsuperscript{15}, 0.6 % in Canada 1988-1989 (Sender Beauchamp and McDaniel 1990), 6 % in Egypt 1951–1981 (Moussa 1986), 1.2 % in France 1980 (Moussa 1986), 1 % in Sweden 1980 (Moussa 1986). A recent study of women’s patented invention in the European Union 2001-2003 does however show somewhat higher percentages, e.g. 8.3 % in the European Union as a whole and 23.1 % in Lithuania, 4.8 % in Austria and 6.1 % in Germany (Kordele 2007)\textsuperscript{16}. These numbers indicate that there has been a change. It is however difficult to make comparisons since methods of calculation varies or are not presented. Women’s percentage of individualized patents in this study reflects individuals rather than patents, even though women with many patents complicate the image. Most female inventors do however only have one patent which makes this less of a problem.

Like most western countries Sweden has a relatively low percentage of women among inventors compared to eastern European countries like e.g. Lithuania where the percentage of women among inventors is higher but the total number of patent applications is low (Kugele 2007). The comparison with other countries does not alter the general image in which women inventors remain a minority.

Patented invention has increased but the gender gap remains virtually unchanged, something that is a bit astonishing considering that Swedish society has changed a lot during the 20\textsuperscript{th} century to become considered to be one of the most gender equal countries in the world. During this period women have gained access to higher education in technology and hence also to occupations within technological industries, something that may explain the increase in the numbers of patents by female inventors and their presence in industrial settings.

The gender gap does however not seem to have been influenced much by this change. The percentage of women may even be higher during the former period than during the 1990s since female inventors may be hidden behind the initials of inventors in patents owned by organizations. The insight that women were almost as likely to invent in a society that refused women many basic human rights as in the democratic society of today rises many questions. Maybe women were more inclined to participate in the shaping of technology during the late 19\textsuperscript{th} century and the early 20\textsuperscript{th} century, which was a period when the ways in which society was structured according to e.g. gender or class was being challenged by the emerging women’s and worker’s movements. If so, the unchanged percentage of women among inventors during the 1990s indicates

\textsuperscript{15} The percentage refers to patents with one or more woman among the inventors.

\textsuperscript{16} The percentage refers to inventors in patent applications.
that women for some reason have become less inclined to participate in the
shaping of technology relative to men even though they have gained access to
relevant education and employments. This inevitably raises further questions
about the contexts and conditions of women’s invention.

The patent registers provide information about where women’s invention has
taken place. During the period from 1885 to 1929 more than half of the female
inventors lived in the Stockholm region. During the 1990s about two thirds of
the female inventors lived in the regions of the three largest cities in Sweden -
Stockholm, Gothenburg, and Malmoe. This probably reflects the process of
urbanization that followed the transformation of Sweden from a rural to an
industrial, and post-industrial, society. The more egalitarian gender contracts in
urban areas compared to more traditional rural areas (Forsberg 2006) may also
have attracted women and facilitated their inventive work.

Furthermore most of women’s inventions during the 1990s were owned by
industrial firms whereas only a smaller part was not. This indicates that most of
Swedish women’s patented invention during the 1990s has taken place within
industrial settings. During the period from 1885 to 1929 on the other hand most
women probably invented outside of industry.

During the 1990s most female inventors invented in groups whereas only a
small part invented solo. Most groups were gender mixed and only a small part
consisted of single gender groups. During the period from 1885 to 1929 on the
other hand most female inventors invented solo and only a few were part of
small mostly gender mixed groups. Hence women’s invention has changed
from most often being an individual endeavour outside of industry during the
period around 1900 to most often being a collective gender mixed industrial one
during the 1990s.

The explanations given by previous research fit rather well with the image of
invention which is assembled in this chapter apart from that contemporary
patents reflect women’s work within industry rather than women’s work within
e.g. care, where many women work today.

The character of women’s inventions has changed during the last century. Most
of women’s inventions during the 1990s had the character of conventional
technology in the sense that they reflect industrial problems whereas inventions
of a women’s sphere character, e.g. related to the personal or the domestic
sphere or women’s work, were the exceptions. Even though ‘Human
Necessities’ including medical science and hygiene constituted the largest
group, most of women’s patents actually had to do with conventional
technology like e.g. information and communication technologies as well as
new materials.
During the period from 1885 to 1929 women’s inventions often, but not without exceptions though, reflect problems of a personal or domestic character or problems within professions that were open to women like e.g. dairymaid (Sommestad 1987) but that had little to do with established industrial firms. The inventions often had to do with e.g. cleaning, furniture, clothes, hygiene, health, care, and pedagogy but also with chemistry, vehicles, tools, security devices, and weapons.

Hence most of the patented inventions of Swedish women reflect their presence within industrial research and development today and within the domestic sphere of the household or professions open to women a century ago. Women still invent personal or domestic things though, but not to a large extent just as they invented non-domestic technology like e.g. weapons a century ago. That there are few inventions related to the domestic sphere today may have to do with that they are seen as too simple and ordinary to patent (Salmi 1997). Never the less, women’s inventions show a great variety both in the 1990s and in the late 19th and early 20th century encompassing everything from hygiene pads to machine guns.

The study of patent registers provides a broad image of how the extent to which Swedish women have invented, the contexts in which these women’s invention took place, and the actual inventions they patented has changed over time but reveals nothing about the actual process of invention, i.e. how the inventors came up with the ideas for their inventions or if and how these ideas were realized. That neither unpatented nor classified inventions are included highlights that it is a partial image. Like others before me I have learned that many inventions never are patented and that women have fewer patents than men (Stanley 1993) and I conclude that studies based on information from patent registers can not give sufficient understanding of the conditions of women’s invention (Moussa 1986, Schützsack 1995). In order to capture more aspects of invention the image of women’s invention in patent registers that has been presented in this chapter - an image assembled from a broad but rather shallow source of data - is accompanied by complementary images of women’s invention assembled from data reflecting more specific in-depth examples. In the next chapter these specific examples of women’s invention are situated in practice.
V Women’s Invention in Practice

The previous chapter provides an image of women’s invention assembled from broad but rather shallow data in patent registers. In this chapter a complementary image of women’s invention as situated in gendered practice is assembled from data reflecting some more specific in-depth examples. The examples of women’s invention include invention within large organizations - industrial producers and providers of care in this case - as well as entrepreneurial invention within existing small firms or emerging start-ups. Sometimes invention within large organizations leads to entrepreneurial start-up of new firms. The image assembled here zooms in at the character of some examples of women's inventions and places them in the contexts where they originated as well as the contexts of their realization and use. The image this chapter provides is also a partial one since the selection of examples has been done without knowing if they are representative for all female inventors in Sweden - a group whose extent is still unknown. Hence, the image would undoubtedly be even more complex if the entire group of female inventors in Sweden could be reflected. I have decided to use the present tense in the text as a way of bringing the reader closer to the examples that are given even though the interviews were performed some years ago.

Inventing for Industry

The image assembled out of data from patent registers in the previous chapter showed that most of women’s patented invention during the 1990s took place within an industrial context. Swedish industry is male dominated since only about one fourth of its employees are women. These women constitute less than one tenth of all employed women in Sweden (Statistics Sweden 2008). Some of the examples of women’s invention that are presented in this chapter come from industrial contexts. The first example has to do with electro-mechanical technologies from the automobile industry. The second example has to do with information and communication technologies from the electronics industry. The third example has to do with hygiene technologies from the consumer goods and paper industry.

Making Automobiles Safer

Vehicle Engineering Inc. is an automobile maker which was founded in Sweden in the early 20th century and now a subsidiary of a large multi-national company. My informant Victoria at Vehicle Engineering Inc. tells me that she is a manager of biomechanics and active safety research with a degree in mechanical engineering. She tells me that she works with automobile safety, does research on whiplash and has an interest in man-machine interaction and
biotechnology. She has for example worked with a side collision curtain that has to work in roll-over situations, but also with gender and diversity issues at Vehicle Engineering Inc.

Victoria tells me that she has the privilege of managing a research project of her own and that more and more people have become involved in her project over time. She describes her work as relatively free, with a lot of contacts with researchers. According to Victoria a lot of people are interested in her work. “The car seems to concern almost everybody.” She tells me that she tries to understand how injuries appear in car accidents in order to find ways to prevent them. Learning is part of the task and she tells me that she develops new theoretical models, new knowledge, and that sometimes research is needed.

Victoria tells me that she sees patenting as a bit old fashioned and claims that they are bad at patenting their inventions at Vehicle Engineering Inc. since few find it worthwhile. She tells me that a lot of their inventions are “small” and never get patented. When something is patented everyone who has participated in the process is included in the patent and there is some compensation for patenting, a few thousand Swedish crowns to begin with. According to Victoria patents are more of a merit in the US than in Sweden. To have an education does not have the same status in Sweden either, she says. But Vehicle Engineering Inc. is an American company now, she concludes. She tells me that it was because of a colleague that she applied for a patent at first. She learned how patenting is done but does not see it as self-evident to apply for a patent for something. “The idea may seem too basic and simple.”

Good ideas from the employees are also collected by the company to an “idea pool” she tells me. To come up with ideas to the “idea pool” does however not give the same credit for someone who has idea generation as part of his or her work as for someone who has not. “It is a pity that only some of all good ideas get realized.” She tells me that quite a lot of external inventors call and that their inventions have to be evaluated. They are often rejected, but sometimes parts are useable. At Vehicle Engineering Inc. ideas are presented to and evaluated by a group of critical people from economy, management, the patent department and the research community. She tells me that decisions to develop an idea are based on estimations of the economy of the project and the possibilities to succeed made by a group. Another reason to proceed can be to claim an important field.

Victoria tells me that the concretization of an idea means an adjustment to the product of which it is going to be a part, an adjustment where negative functions have to be avoided. Concretization is something that is often outsourced, something she tells me makes misunderstandings more difficult to correct. Long-term cooperation does however lead to very integrated work. She
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tells me that ideas related to test methods are handled quite differently and that they build test rigs themselves. Knowledge from customer surveys and clinics does also go to product planning and then to automobile safety where she works. She tells me that she has had the opportunity to influence the questions that were asked.

Victoria tells me that she has participated in the communication about products at trade fairs too. She reflects about what being a woman in a male dominated company has meant to her. “[The company] wanted to promote me as a woman. It was just to accept and be grateful.” She tells me about the benefits of being promoted. “If you start to become visible, you get to be a part of more and more. You get the opportunity to influence in different settings, particularly within the company.” She tells me that recognition as an expert has given her the opportunity to influence not only within the company but also authorities and politicians.

Controlling Digital Information
InfoCom Tech Inc. is a multinational provider of telecommunication and data communication systems and related services which was founded in Sweden in the late 19th century. My informant Emma from InfoCom Tech Inc. is a strategic product manager with a background in research and development. She has an engineering degree in electro technology from the Royal Institute of Technology in Stockholm. Emma has three patented inventions, one which she invented individually and two as part of a group. Invention has been part of her job but today she has moved upstream from invention and she sees it as unlikely that she will invent again. She is still part of the process but she does not do solutions herself anymore. She is rather involved in the reformulation of problems. To have some patented inventions and the experience of invention does however give status in the professional role in terms of recognition as a good developer.

Much of the invention that takes place in research and development at InfoCom Tech Inc. is about improvements or new ways of applying a known technological solution, e.g. solutions that have become cheaper and possible to use. She contrasts with research laboratories at the universities that work for longer periods with problem solving and may come up with radical inventions. Even though most people in research and development work with what she calls “ordinary invention” they do sometimes come up with good and patentable new solutions. The more difficult problems are often given to inventors that are known to be good. It is only those who have contributed a lot to the invention that are named in the patent.
According to Emma the products of InfoCom Tech Inc. are of a systems character which makes standardization important. Ideas can be generated after the process of defining and reflecting on the problem. The problems to solve are chosen in relation to what the competitors do, how standardization is going, what the customers want and what is economically reasonable. The problems are defined through systemization, a structuring of the project in which techniques like e.g. brainstorming are used. She describes it as a process in which the problem is thought through and formulated. It can be about defining what kinds of improvements that are wanted, for example to put into use new technical solutions or solutions that have become cheaper and hence possible to use. When it comes to systems it can be about making them cheaper and faster but also about increasing the capacity for data processing, improving cooling functions or reducing unwanted noise.

Ideas that do not fit in the project are cared for and steered to the right place within the company or sometimes lead to the start up of a new company. Emma tells me that the problems to solve are defined within given frames and may be broken down to partial problems that are given to groups or individuals to solve whereupon the solutions are put together again. Coordination is used to avoid divergence among the groups.

Phenomena to be mastered can be explored and experiments can be used to achieve knowledge. The ability to think in new ways does according to Emma demand a certain amount of education in order to make new use of old knowledge, borrow solutions from other fields, combine old solutions in new ways, scaling up or down known solutions or turning them around somehow. Quite a lot of the work is of an analytical character she tells me. When you change field of technology, part of the job is to study the new field. When it comes to “small” inventions the knowledge you have is often useful and additional knowledge can often be found within the company. “Large” inventions on the other hand demand more research; you may have to learn something entirely new. When new components are involved a world wide investigation of who can produce them is done. Sometimes external resources are engaged.

Emma tells me that the economic compensation for inventions at InfoCom Tech Inc. is based on the complexity of the invention and the reaction of the market. There is also some economic compensation in order to encourage the inventors to go through the tedious process of patenting their inventions. There are double reasons for patenting, both to protect your own invention but also to avoid having to pay expensive licenses for using inventions that others have already patented. Hardware inventions are often patented. Hardware is often done
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before software, but can be modified later to fit. Software is more difficult to protect since it is difficult to know if an idea is new or not.

According to Emma invention is only a small part of the long process from idea to product. The concretization of ideas often starts with writing, drawing and structuring. Those who work with parts that are close to the user often know a lot about what the customers needs and wants, in other cases they have to guess. She also sees the surrounding groups within the frame of the development project as a kind of users. She emphasizes that it is important to include the opinions of the final users throughout the project and not only in the beginning. When a prototype is built its functionality is tested. In order to get feedback from customers Emma tells me that prototypes sometimes are shown to customers under mutual contracts about not disclosing anything to the competitors. When the invention is made into product, produceability, laws, etc. have to be taken into account. Depending on what kind of product it is, customers are involved in tests. When it comes to mobile phones the customers are operator companies, she tells me. First Office Applications are when positive customers get to try the new product for free but have to endure the adjustments of ‘children's diseases’.

Sometimes Emma finds inspiration for her work in her children’s toys like Play Station, radio controlled cars etc. But to read something, she tells me, may also lead to new creative associations that can be of use. Here we leave Emma and the relatively new field of information and communication technologies and move on to the field of hygiene technologies.

Absorbing Bodily Fluids

Urinating is a body function which we normally learn to control. For various reasons people sometimes fail to control the need to pee, something that causes obvious problems. After childbirth many women experience this problem. Menstruation is a body function of women which also poses problems to solve. In some cultures and back in time women were considered unclean during menstruation, something that seriously limited their possibilities to participate in everyday social life. In contemporary western society hygiene technologies allow women to go on with business as usual, or almost as usual. No one except the woman in question needs to know when she is menstruating since products like sanitary pads or tampons absorb the blood.

Intimate Innovations Inc. is a subsidiary of a multinational provider of consumer goods and paper which was founded in Sweden in the early 20th century. Intimate Innovations Inc. has a research and development department which works primarily with incontinence and menstrual products. Christina and Alva are both involved in the processes of inventing and developing new
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hygiene technologies. They tell me that the company has some trouble keeping research and development staff who are tempted to move on to sales or marketing. To be a project leader is valued higher by many than to be a product developer. Hence, the company has created an opportunity to have a specialist career with similar development of salary and status as for a managerial career. When it comes to technology the “hard part” focuses on production processes whereas the “soft part” focuses on consumer needs. Knowledge about different materials and their interplay is central in the accomplishment of the wanted functions. The demands are grounded in the envisioned product, in the wanted function.

The research and development department works primarily with research and early development projects. Most research is performed within the limits of present strategies and fields of competence, but they also do some exploratory research. There must be a market for a new product; otherwise it has to wait as a “shelf solution” until the time is right. At a particular time it can be difficult to e.g. produce the product in a sensible way or at a reasonable cost, something that may change over time. Radical ideas are generally stored within the company without being developed. The research and development department is an industrial laboratory in which women and men work side by side, creating what is to become the intimate innovations of tomorrow. Incontinence and menstrual products are discussed in terms of complex and sophisticated high technology. Genital anatomy and properties of bodily fluids are discussed as in-data in the innovative research and development processes.

The work at the research and development department is performed both in groups and individually. Development projects have gender-mixed crews. Project groups consist of a competence mix adapted to the project in question. Christina and Alva see differences in terms of experiences as something that gives a positive dynamics, a view with they feel has support at a managerial level. Women’s first hand experiences of some of the problems that are addressed by research and development is at the one hand considered as a resource but on the other hand as a risk of loosing objectivity in relation to the problems at hand. The experience of one particular woman is not necessarily representative for all women. They tell me that there are a lot of women within “Feminine”, the group which works with menstrual products. On the other hand, there are a lot of men within the process groups. Apart from providing the right competence, recruitment aims at achieving a gender balance within the development groups. The informants see gender balance in the working groups as a means of improving the working climate. It is however not considered particularly “macho” to work with menstrual products, something that may work against an increased participation of men.
Christina and Alva tell me that the groups “Feminine” and “Inco” do a lot of market research, studies and focus groups. Consumer problems or needs are identified and turned into solutions in form of products. They also get a lot of feedback from marketing, e.g. about what their competitors do. The “Feminine” group has started to look out globally, which means somewhat different demands. The “Feminine” group tries to see needs before the consumer sees them, but do sometimes also address user demands.

Christina and Alva tell me that product areas set the limits for research and development and the work is performed within projects. Ideas can come from anywhere within, and even from outside of the company. If ideas come from the outside the policy is that they must be patented before the company takes part of them. All ideas are collected in a data base together with search keys. The database is a resource for all projects that are started up. Radical ideas, ideas that do not fit in, are also stored in the data base. There are also groups that study patents, choose countries and markets. Christina and Alva tell me that the company works with utopian products too, something that has given a lot of spin-off effects and learning. Visionary ideas do not always become products since the users wouldn’t accept them even if they actually work very well. It takes time for ideas to become parts of products and some ideas never get realized. The informants also emphasize that it is okay to make mistakes.

They tell me that prototypes can be produced in the prototype centre for tests, e.g. user tests or focus groups. The initial prototype is generally a very simple one. Most of the work is about materializing the invention as a prototype. During this process of gradual adaptation additional invention often takes place. When it comes to production they tell me that the process developers are included from the start. Production must be cost effective. Expensive solutions are never realized. It is a process of adapting to the given preconditions.

In the realm of hygiene technologies we have met Christina and Alva from an industrial firm that addresses problems related to women, to the female body. These examples from industry show that industrial invention encompasses quite diverse technologies that are not only made by men for men. Here we leave the examples from industry and move on to some organizations that provide care.

**Inventing for Women’s Work**

Some of women’s invention is related to women’s work in the sense of work that is most often carried out by women. In Sweden the health and care sector is dominated by women since more than 80 % of its employees are women. 87 % of the orderlies, 90 % of the nurses and 47 % of the physicians are women. 30 % of all employed women in Sweden are found within health and care
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(Statistics Sweden 2008). It is within the health and care sector that the following four examples are situated.

**Enabling Disabled Children to Exercise**

Kerstin has, together with her colleague Else-Mi, invented and developed a play-tool in the shape of a horse intended for practising balance and perception of the body among more or less gravely disabled children, something she tells me that they missed in their work with disabled children. Kerstin tells me that it all began when she and her colleague Else-Mi were searching for materials that they could use in the habilitation of disabled children. “When one works one discovers needs at work.” They were looking for some kind of training and playing device for children with various dysfunctions. They wanted to find more variations. At this time they had many ideas from before that they had not done anything with. One of these ideas was to develop a special kind of rocking horse. They decided to try to make something out of this idea.

Kerstin describes the rocking horse as mounted in rubber suspensions, something which made it move in all directions and enabled most groups of disabled children to practise their body balance. The horse can also be equipped with specially adapted saddles that enable even quite gravely mentally disabled children, who need to practise their body perception, to be strapped and sit by themselves. She tells me that they painted the horse with anti-glide colour to avoid sliding and that they had different kinds of carpets to stimulate the children’s feet that could vary in sensitivity. Apart from that the horse is equipped with a resonance plate on which different things can be placed for sensory stimulation.

Kerstin tells me that they lent the rocking horse to different places in order to test it. It worked very well and became very popular among the testers. The supports were tested several times in order to develop a solution that was adjustable for children with different kinds of handicaps, who were often frightened to sit on something that was not stable.

Kerstin tells me that they only made eleven horses since they were quite expensive to produce. They had also developed another product which was at the prototype stage when Kerstin had an accident which made it difficult for her to continue working. She tells me that she was in quite bad shape and limited in what she could do physically after the accident. Due to this, she has had to solve many problems of her own. This problem solving resulted in her making a number of different aids for herself. Her motivation was now to make her own existence somewhat more tolerable. She tells me that after the accident she has not been strong enough to continue her work with developing aids for others. Hence, they decided to sell the rocking horses and the company has been
resting since then. What will happen to the other product which had come to the prototype stage future will tell. "It is slumbering, but there is nothing that says that it will slumber forever." Kerstin tells me that if they decide to go on with the other product, they probably won’t do everything themselves this time. To sell the idea or to cooperate with a producer she sees as a more probable solution in that case. Kerstin tells me that she enjoyed the creative development process.”… I still have many ideas that I could consider developing.”

Here we leave Kerstin and her invention related to work with disabled children and move on to Monica and Anne-Marie and their invention related to the care of demented patients.

Caring for Demented Patients

Another example comes from the care of demented patients where Monica works as an orderly. Monica and her sister Anne-Marie, who works with mentally disabled children, have designed nightwear specially adapted for demented patients.

Monica tells me that a recurring problem in the care of the demented was that many of these patients ripped of their diapers at night and soiled themselves and their surroundings. This resulted in considerable work with cleaning the patient, changing night clothes and sheets as well as cleaning the surroundings. This was something that could be repeated many times per night for one individual. It was a problem not only for the personnel but also for the patient who got his or her night sleep seriously disturbed. Sometimes the personnel wrapped the patients in sheets to prevent them from ripping of their diapers. This was a solution of the problem that Monica tells me she was not content with. She wanted to find a worthier solution of the problem. She had an idea of making a nightwear in the form of a bodysuit, where shirt and trousers are integrated, preventing the patient from removing the diapers. She turned to her sister Anne-Marie, who had a sewing machine and sewing as a hobby, for help with the design of the nightwear.

In the first attempt they sewed together a t-shirt and a pair of men’s underpants and put elastic in the waist. Monica brought the garment to work and tested it on the patients. It turned out to work well. Monica and Anne-Marie tell me that they had many discussions about how the nightwear should be designed and which materials would be suitable. Through her working experience Monica knew how the nightwear would be used and the demands this posed on its design whereas Anne-Marie, who had sewing as a hobby, had good knowledge about different materials and sewing techniques. In this sense they completed each other.
They made three different successively improved prototypes, which were all tested on the patients. The prototypes worked very well and Monica’s colleagues encouraged her to go on with developing the invention. After having tested the night wear at Monica’s workplace people started phoning wanting to buy it. It was the extra personnel who had worked night at her workplace who wanted to buy the night wear to their ordinary workplaces.

Monica and Anne-Marie tell me that they spent a lot of time searching for the right material and the right manufacturer for the product. They bought fabric which they tested sewing from, e.g. a material the army uses, but the night gowns became to saggy. The manufacturer they decided to engage turned out to have many fabrics which they could choose among, which they did. “It was supposed to be soft and comfortable but at the same time easy to wash. We actually wanted a coloured fabric, but it did not work out.” The night wear is sewn in soft white tricot. Monica and Anne-Marie tell me that they want to try to keep the product cheap since the primary customer is the patient, or rather his or her relatives. Only on a few occasions a municipality or a county council has paid for the patients’ night wear, despite that it saves both work and costs in the care of demented patients. They tell me that they think that it will take some time before their product goes well. “Decisions take time within care and it is not supposed to cost anything either.” But they believe that the nightwear will be successful eventually since it would not take long to regain its costs. They tell me that they have many other ideas of new products too.

Here we leave Monica and Anne-Marie and their invention related to the care of demented patients and move on to Inga and her invention related to the care of the very sick.

**Caring for Very Sick Patients**

To perform care work without disturbing sharp sounds and with high demands concerning hygiene is of particular importance while caring for the very sick, who are sometimes in the final stage of their lives. Inga’s invention, a silent universal working table for care work, is an answer to a problem she had herself experienced in her work as a nurse at a nursing home for the elderly. Inga tells me about an event that preceded her idea.

Together with an orderly she was about to help two elderly men where one had had a stroke which led to severe physical and mental injuries and the other had far progressed Parkinson’s disease. Inga tells me about one night when they were to help these two men to bed. “As we had got these persons to bed we had dirty laundry and used diapers everywhere in the room, on the floor, in the waste bin, in the washbasin, and on top of the newly made clean beds of the patients. We tried to keep the clean and the dirty apart according to the hygienic
demands that medical service poses on their employees, but it was not so easy when we had no adequate working tools. It was both time-consuming and laborious to collect all dirty laundry and diapers.” Inga tells me how the orderly in the middle of the commotion suggests that she finds a solution to improve their working conditions. Out of these experiences grew the idea to develop some kind of work table or wagon in order to facilitate the separation of the dirty and the clean, which would be good for both patients and nursing personnel.

Inga describes how she, while reflecting over the problem of how to separate the clean from the dirty, started making sketches of her own. Later she turned to an engineer who did the first real technical drawing of her work table on wheels. Inga realized that she needed help from someone with knowledge from production in order to be able to visualize her idea further. She contacted many workshops but most of them were not interested. Through an adviser she finally got in touch with a workshop that could help her. It took Inga almost a year to produce the first prototype of the work table. For the second prototype she looked for a new producer. The work with the prototypes took a lot of time.

Inga tells me that she interviewed nursing staff, who were very positive to her idea of a functional work table. Later she tested three work tables in care work. She got a lot of feedback and suggestions about changes that have been very useful to her in the development process. The response on her work table was positive and it was seen as something that improved both the working environment and aspects of hygiene. Inga tells me that she has functioning prototypes that have gone through extensive user tests in care work. She has contacts with a company which is interested in producing her product. What happens, the future will tell.

Inga believes that she will continue inventing and developing products. She has many different ideas. She sees a great need for new and improved tools for care work. She tells me that nursing personnel have to make do with tools which come from companies that often have no contact at all with care. She thinks that the lack of functional tools is a consequence of that those who develop the tools don’t know for what and in which context the tools are to be used.

Here we leave Inga and her invention related to the care of the very sick and move on to Margareta and her invention related to the care of bed bound women.

Meeting Bed Bound Women’s Need to Pee

Like all people bed bound women need to pee, but must do this while confined to a bed and with assistance of nursing personnel. For long these women have had to make do with the common bedpan which is adapted to the male
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anatomy. But women’s and men’s genital anatomy differ, which makes the bedpan solution of women’s peeing problem a leaky one, causing unnecessary extra work for the nursing personnel and discomfort for the woman.

Being a former midwife Margareta understood that an adaptation to women’s anatomy would solve this problem. When she was given the opportunity to adapt an existing prototype of a urine bottle to women’s anatomy she decided to go for it. Based on her experiences and knowledge from being a midwife she instantly realised that this was something that was really needed.

Margareta had an existing prototype as a point of departure. She manufactured a simple test series consisting of 20 bottles, which were thoroughly tested. Initially it was she herself, her friends and her mother who tested the bottle. As the urine bottle was found to be too high Margareta cut the test bottle in different heights for further testing. Margareta had contacts within the public medical service and she got help from patients and personnel who tested the urine bottle for six months. She made a survey that showed that most of both patients and personnel were satisfied with the urine bottle. This gave her confidence to have a cheap tool manufactured.

Margareta tells me that the product was developed through adjustments to use and production. The shape of the urine bottle was a result of the tests that had been carried out. She made it easy for herself by selecting the same material that was used in an existing urine bottle for men. She tells me that the road has not always been straight and without problems. An innovation adviser recommended her to injection mould the urine bottle in two pieces and to weld the two parts together. She had an expensive tool made, but unfortunately the urine bottle could not be manufactured that way since the welding turned out to leak. This detour cost her two years. “I don’t regret anything apart from that I should have trusted myself more and others less.”

The urine bottle had to be produced with another method, blow moulding. The choice of manufacturer was simplified by the fact that only a few of the Swedish manufacturers do this. Margareta tells me that she owns her own tool but has plans to have a new one made since the old one is wearing out.

Margareta works part time with her company since she wants to spend much of her time with her son. She tells me that her work with the urine bottle gave her control over her own time. She tells me that she has met expectations that she ought to develop more inventions within health and care, for instance a smaller urine bottle for children. She tells me that she might consider continuing to invent if something interesting comes up.

Margareta and the other women who have invented within care giving organizations were not able to develop their inventions there and hence had to
Inventing for Women’s Bodies

The women who invented for care work had to start firms of their own and become entrepreneurs in order to develop their inventions. The study of Swedish women’s patented invention showed that even though most of it takes place within industry about one fifth of it takes place outside of industry. Where unpatented invention takes place can not be said for sure, but it is not improbable that a lot of it takes place outside of industry. In Sweden 25 % of the self-employed are women (Statistics Sweden 2008). To become an entrepreneur can hence be seen as an unconventional choice for a woman, particularly if she starts a firm aiming to develop a new technological solution of some kind. As we have seen the technologies that are invented by these women sometimes provide solutions to problems experienced in women’s work. As we have seen care work has a lot to do with the human body. Some of women’s inventive work also addresses problems related to human bodies, but outside of care work. Here follows some examples of inventions that are related to women’s bodies.

Meeting Women’s Need to Pee

Urinating is a biological function, a need that must be met. Small children pee whenever they need to, e.g. in diapers. As we grow older we learn to control our need to pee in time and space. We pee in between activities and in particular places: toilets. If the need is urgent and no toilets are available, or if they are unacceptably dirty, any secluded spot may have to make do. This is where the social practices separate men and women. It is much more accepted for men and boys to pee in public than for girls and women. We may also need to pee during the night, which may mean drowsy nocturnal walks to the toilet that may sometimes be risky. In order to reduce the peeing related restraints in time and space Carola has invented a portable potty which is primarily intended for women and which may be used while standing up.

In Carola’s case it was her mothers-in-law who gave her the insight in a problem that she sees as common for many older women and some men too: the need to pee often. One of Carola’s mothers-in-law had to go to the toilet many times every night. During such a nocturnal walk to the toilet the mother-in-law,
dazed by fatigue, fell and hurt herself so badly that she could not get up. The mother-in-law died as a consequence of this incident. Unfortunately her faith is not unique; many older women fall and hurt themselves while going to the toilet by night.

Carola’s other mother-in-law told her about how she as a salesperson during long automobile journeys in Germany brought a can to pee in. Carola used the same method herself when she was on her boat. She realized that a can at the bed table could spare many older women from risky walks at night. But she wanted something nicer than a can for them to pee in. An easily available chamber pot would mean that they do not have to go to the toilet at night when they are sleepy or dazed by medicines. As a solution of the problem Carola wanted to make a chamber pot that was not only practical and hygienic but also beautiful, so it could be placed at the bed table and be at hand when needed. Such a small portable potty would also be convenient to bring along in case you would need it while travelling or so.

Carola describes urinating as a women’s issue since many older women encounter related problems of various kinds, like e.g. having to pee often. She tells me that she found out that there had been potties that resembled hers back in history, but then made out of porcelain. In relation to her own product development process Carola tells me that she has searched for information about how problems related to peeing have been solved back in history and in other cultures. She did however not find much documentation. She sees it as a part of the history of technology which has not been very well documented.

Carola tells me that the concretization of her idea meant a lot of cutting and pasting. She made a potty out of thick paper and wood blocks which she dipped in paraffin in order to be able to perform tests, i.e. pee in it. Carola tells me that she engaged “a lot of helpful men” - engineers, technicians and a designer - in the development process. But it was difficult to control them, she tells me. She was inexperienced and trusted them a bit too much. "Men always sound as if they know everything, even if they don’t. But they intend no harm.” Carola tells me that she got a lot of help from women too. She was part of a group of female inventors who supported each other during the development process. She tells me that they could solve almost all problems that occurred during the development process in the group.

The development process resulted in an oval potty that allows women to use it standing up. Carola tells me that the potty is primarily intended for women but that it can be used by men too. A special benefit is that the design of the potty enables women who can not easily sit down - e.g. those with back-, hip- or knee problems - to use it. And in order to keep the potty hygienic it can be washed in the dish washer, she adds. A lot of adjustments to production were needed too.
Apart from the original potty Carola has also developed a variant for people in wheelchairs and various accessories.

Here we leave Carola and her invention that meets women’s need to pee and move on to Mia and her invention that facilitates public breast feeding.

**Facilitating Nursing in Public**

Nursing in public often meet unwanted attention and sometimes even disgust, as if the public sphere is still not really a place for women and children. Women’s breasts are met with ambivalence in social life since they are simultaneous symbols of motherhood and sexuality, incorporating both the Madonna and the whore. On the one hand women’s breasts are often exposed in public commercials and in many magazines. On the other hand women are still expected to cover their breasts in public, sometimes with the beach as an exception. When this obsession with breasts in western culture meets nursing women who no longer wants to, or for practical reasons cannot, stay within the boundaries of their home problems may occur. This is something Mia observed when her sister got her first child and which made her develop clothes for nursing women that make it possible to breast feed without being exposed to cold winds or unwanted looks.

In Mia’s case it was in relation to her sister having a son that she gained insight in a problem previously unknown to her. One autumn day when they were having coffee outdoors her sister pulled up her top to nurse the child. Her sister’s naked stomach and breast was exposed not only to the cold wind but also to the people surrounding them. Mia wanted to protect her sister not only from the cold but also from all who were looking. She thought that there must be a way to solve this problem. She envisioned making a top that makes it possible to keep the fabric on the stomach while nursing to avoid exposure to cold winds and looks of others.

Mia tells me that she sewed the first prototype of the nursing top herself. She tried to draw an exploded view of the nursing top for the patent application. She drew the sketches which were needed for the patent application but hired a patent attorney to write the text. As a preparation for the coming production she contacted a friend who is a designer for help with the design. Her designer friend, who has children of her own, liked her idea.

Mia tells me that she let students at Mälardalen University do her business plan and a small market survey, which showed a rather low interest in her product. Only a small percentage of those who were asked said they would consider buying her nursing top. Mia tells me that she only had two prototypes, pictures that she had taken of her sister and sketches at that time, something which she think made it difficult to do a market survey.
Mia sees marketing as very important since it places the product in a context. She sees practical as well as emotional aspects as important in relation to clothes. Mia tells me that her sister, who was actually nursing at the time, got to do tests now and then. She did no bigger test before she ordered the first series. “Now we do tests all the time.” Mia hopes to be able to keep on developing products in the future. “I want to do new things within the field I have chosen. I know how much work it takes to develop something new. That’s why I want to build on what I have already done.” Today Mia’s nursing top has been accompanied by other kinds of maternal clothes.

Here we leave Mia and her invention that facilitates nursing in public and move on to Carin and her invention that makes bouncing breasts stay in place.

Making Bouncing Breasts Stay in Place

Women’s breasts sometimes constitute a problem in terms of e.g. discomfort or pain, particularly in relation to physical activities. In ancient mythology the female Amazon warriors cut of their right breast in order to facilitate the handling of the bow and arrow. In contemporary real life Carin is an example of a woman who when bothered by her bouncing breasts while sporting searched for and finally invented a solution to her problem: a sports bra.

Carin worked as a gym leader at Friskis & Svettis and was bothered by her bouncing breasts at every gym session. She wanted her bouncing breasts to stay in place during sports activities. She was looking for a bra which was adapted for sports, but came to the conclusion that there was no such thing on the market at that time. She tested all solutions she could think of, like for instance double bras and different combinations with tight t-shirts but the results were disappointing. Finally Carin had had enough. She took all her savings and went to a private surgeon to have breast-surgery and get rid of her problem. “Big breasts may be a dream for many women, but not for me.” The surgery went well and she was pleased with her new smaller breasts. She was impatient to start training again without her breasts bothering her no more, but her first run became a big disappointment as she noticed that there was no great difference. Her breasts were still bouncing and there was no functional bra for her new smaller breasts either.

During a period Carin worked with health and fitness gymnastics in Central Park, New York. She still hadn’t found any good bra and she was far from alone with the problem of bouncing breasts. Many women she met bandaged their breasts to keep them in place. Carin was still searching for a functional sports bra, without success. She started to wonder if maybe she would have to sew one herself, if only she could find a good material. One day when Carin visited a fabric shop she found a fabric with particular qualities, which seemed
to be the perfect fabric for a sports bra. The fabric was elastic in one direction and inelastic in the other. Carin realised that this fabric could provide the wanted support vertically while still being flexible horizontally.

Carin tells me that she initially had the idea of her bra in her head. When she met those who were to sew her test bra she used simple drawings to explain how she wanted it to be. She tells me that she met mostly men in the factory and that both the clothing and the sports business are dominated by men. When Carin finally could try out the first test bra it turned out to work exactly as she had hoped. The breasts stayed in place during the gym sessions, the shoulder straps did not slide, and it looked good. In the locker room other women asked her about the bra she was wearing. To have a concrete bra instead of an abstract idea came to be crucial when Carin later on was to sell in her product to the sports retailers, who were almost exclusively men and completely uninterested in her product. “Just to talk about a bra was embarrassing for some of them.” One of these managers did however dare to ask Carin what a sports bra was. Carin then rapidly changed into a sports bra and sport clothes and performed a gym session on the floor in the store to show him. The amazed manager bought a couple of sports bras on trial and has been one of Carin’s best customers since then. To be able to show a concrete product in use turned out to be an effective strategy.

Carin tells me that she also let professional athletes test her bra and give their opinions. Apart from that, she herself, her friends and later on her employees have tested the products in use and washed them over and over again to see how well the fabric could support wear and washing. The test results have been used to improve the products. Carin subsequently developed a large assortment of sports clothing and bags, and eventually she sold the company she had founded.

The inventors who invented for women’s bodies either did this within an existing firm of ones own or started a firm in the process. The problems that were addressed stem from the private rather than the professional sphere. Here we leave these inventors and move on to inventors who invent without any particular focus on women.

Inventing without Focusing Women

Female inventors do not necessarily only invent for other women, as we already have seen in the examples from industry. Inventors outside of industry do also invent without focusing women. Here follows four examples of female inventors whose inventions are not exclusively for women.
Suspending Lamps with Style

Design processes offer both aesthetic and functional challenges. Anu has designed a drop-shaped glass-lamp. Her invention is the suspension device for this lamp, which she has patented.

The problem which Anu’s invention solves occurred during a product development process. She tells me that she wanted a lamp for her shop where she sold ceramics and other handicraft of her own production. When she accompanied a friend on a visit to a glasswork it resulted in a strong desire to make a lamp of glass.

Anu started with the glass globe which she wanted to have the shape of a drop with a closed bottom as opposed to most other lamps which have open bottoms. She had one glass globe produced for testing. The problem to solve was how to suspend it and how to get the source of light down in the glass globe. She tells me that she had an initial idea which did not work particularly well. For a period of a year the glass globe stayed at her coffee table and she looked at it during every coffee break until she suddenly got an idea.

The weekend before she got the idea Anu had been working with taking down and removing threes. In this work she tells me that she had used a device which opens over the log as it is placed over it and grips the log during lifts. A few days after that Anu was seated at her coffee table doing the gripping movement over the glass globe and the idea came.

Anu tells me that she realized that she could make a prototype to see if her idea of a suspension device for her lamp would work as she anticipated. She used an old clothes hanger of steel wire to make her first prototype. When she tested it and saw that it worked she realized that her idea might be valuable. For her next prototype she chose aluminium as material. She got in touch with a small company that manufactures aluminium products for a large company. She showed her suspension device to them under a secrecy agreement and they made her a very nice prototype. Anu tells me that she was encouraged to go on by her children and by the positive response on the lamp, which she did. Since then Anu has developed the lamp suspension further into an invisible inverted variant that grips the glass globe from the inside.

Here we leave Anu and her lamp suspension invention for Stephanie and her invention, which has to do with the suspension of buttons.

Reattaching Buttons on the Loose

As a solution to the problem of how to quickly get a loose button back in place, Stephanie invented a device for reattaching buttons. It is needle and thread in one and looks like a plastic strap in miniature. It is made of nylon and may be
washed and ironed. When Stephanie got the idea for her invention she was feed up with buttons that inconveniently fell off from her clothes from time to time, often while on the way to an important meeting or so - a problem most of us are familiar with. On these occasions it was difficult to find needle and tread to sew the button back on and the loose button was often lost. Apart from that she tells me that she is not very good at sewing, something that did not help in these situations.

In Stephanie’s case it was the knowledge about a technical solution to another problem that gave her the idea that solved her problem. Stephanie tells me that she had used plastic straps to gather and attach the cords of stereo equipment. She realized that a somewhat modified strap in a smaller scale ought to be useful for quickly and easily reattaching loose buttons. It did however take a couple of years before she came to realize her idea. Stephanie tested her idea on her husband and some close friends that she trusted and got positive reactions. But in the beginning she saw a lot of obstacles, like finding the time - she was working full time - and the money to develop her idea. And how does one do it? She found the situation impossible and laid the idea to rest for a while.

Stephanie tells me that the largest obstacle when she eventually started to develop her idea turned out to be related to production. Just to make a working prototype became the first obstacle. A large manufacturer said “it can’t be done” whereas a smaller one said “we’ll work it out”. To manufacture the tool took about a year and to find the right material took yet another year. The first prototype was no good since they had a poor material then. Despite that it was a confirmation that it could be done. A lot of product development followed. Many different materials were tested before the right one was found. The test panel consisted of her closest friends and relatives. Stephanie tells me that she owns her tools in order to be able to change manufacturer if she wants to. Stephanie has developed her invention into a product and started a company of her own. She hopes to be able to continue inventing. She thinks that it must be easier the second time around since she knows how to do now.

Here we leave Stephanie and Button clips and move on to Desirée and her adjustable baggage carrier for bikes.

Making Biking with Big Bags Safer

Biking is an activity which combines business with pleasure in terms of transportation needs and leisure wants. Desirée has invented an adjustable baggage carrier for bikes. The device is shaped like a butterfly and facilitates transportation of big bags by allowing its wings to be unfolded. It is intended for use by anyone in the world who needs to transport something big on the carrier of a bike. Desirée describes it as a security device which enables stable
transportation of broad cargo, like different kinds of bags, by a simple broadening of the carrier.

Desirée tells me about how she got the idea for her invention when she was riding her bike on the cobblestone roads of Visby on her way to the ferry. Her big bag kept bouncing of the carrier of the bike over and over again which was very annoying. When she finally had reached and boarded the ferry she asked herself why the carriers of bicycles have to be so small. Then she suddenly had a vision of a complete design. Desirée tells me that it did not look exactly as her product looks today, but it worked the same way.

Later she tells her brother about her idea. He thought it was a fantastic idea, she tells me. "Imagine sis, millions of biking Chinese who all need your product.” But she did nothing with her idea at that time, apart from thinking about it. Desirée could however not forget the words of her brother and after some time she decided to go for it and develop her idea into a product. “I saw it as if though I had been given a chance, a unique opportunity.” She decided to take the chance she had been given, to quit her job at the firm of accountants where she worked and stake everything on developing her idea into a product.

Desirée started the process of realizing her idea by attending a training programme for inventors. During this period she produced the prototype of her product. She built six different models in cardboard before she found the one which is used today. She also made a novelty search via the patent office in order to see if there already were other products like hers. She only found one invention that at all resembled her own, which was no longer on the market. She tells me that she has protected her invention with a combination of design protection, trademark, and patent.

Desirée tells me that she tested her product in many different ways. She established a test network consisting of about 200 persons of all ages, young and old, who use the product and give feed back about its function. She also contacted retailers and asked them if they believed in the product. When Desirée participated in fairs she has had the opportunity to ask a lot of people about their opinions about her product, which resulted in very good response. Students at an engineering programme have tested the product. The product has also been tested by a researcher who studies bicycle accidents and by an insurance company. She tells me that the test of this researchers showed that her product is a security product that may save lives and that the insurance company found that it could reduce the risk of accidents.

Desirée tells me that she started a firm of her own when she started selling her product. She intends to go on developing her ideas into products. She tells me that she also lectures about her way from idea to product and that she would
like to help others develop their ideas. “I have so much knowledge today that I would like to share.”

Here we leave Desirée and her bike related invention for Birgit who have invented a device for the wet sanding of boats.

**Improving Sanding of Boats**

Pleasure boats are not only a means for transportation but do also provide a way to spend ones leisure time. Birgit’s first invention, a device for wet sanding, was related to her personal interest in sailing. The device for wet sanding can be used to clean boats from dirt, residues of old colour and on growth of sea plants before repainting, something a boat owner has to do regularly.

Birgit tells me that she used to clean her boat with paper for wet sanding and a bucket of water. This was not only hard but also time consuming work. Birgit wanted to find a more efficient way of doing this work, preferably without getting all wet while doing it too. This is the problem her idea was an answer to.

Birgit got the idea to combine a hollow handle with a hollow abrasive product that had a perforated sanding surface on which a perforated abrasive sheet could be attached. Then a hose could be attached to the handle leading water out through the perforations wetting the abrasive sheet continuously, hence making sanding more efficient. Her idea turned out to work very well, but at that time Birgit just made one for herself and her family without any intention of developing a product. People who saw her using the device became interested.

Birgit tells me that it took some time before she decided to quit her job and start a firm of her own to develop the invention into a product. Birgit’s background as an engineer facilitated this process. She used to work with designing and building measuring devices as well as running and evaluating experiments for researchers at a nuclear research reactor before she started a business of her own based on one her invention. When Birgit started to develop her invention into a product she built and tested the prototype herself. Here, her previous working experiences came in handy. She tells me that she knew what she needed to know about the boat market too, but that she did not know much about sales.

Birgit tells me that she assembled the product herself, but that she outsourced the manufacturing of some parts of the product. She chose the first manufacturer based on geography, which turned out to be a mistake. The handles of the sanding device broke and users complained. The handles were made of the wrong material, at the wrong temperature and at the wrong pressure. Fortunately she had made her own tool, which enabled her to change manufacturer. From this mistake she learned about the importance of taking
Birgit has continued to develop other inventions after the device for wet sanding. Several of her inventions have to do with boats. Apart from the sanding device she has invented e.g. a navigation device, a mooring buoy, special bags for ropes, a mailbox with transparent bottom which earwigs do not like, a solid design for windows and doors, and an automated chimney sweeper. She tells me that she has no specific strategy for what she invents; it is rather completely new ideas that just pop up in her head. She does however always let her ideas rest for a while to see if they still seem interesting after a few months, if not they end up in the wastepaper basket. Birgit’s inventive work has resulted in a number of new products and in her becoming an entrepreneur.

As we have seen here, women does not necessarily invent exclusively for other women. Their inventions can also be solutions to problems that humans in general may encounter in various situations.

**Diversity and Specialization**

When the qualitative data is broken down and reassembled an image of what is invented, in what context and for whom emerges. The examples of women’s invention within an industrial context turned out to encompass diverse technologies not only intended for the use of men, some were also intended for women. Women’s invention within care addressed problems encountered in women’s work and resulted in the start up of spin-off companies where these inventions could be developed. Some of these women kept on working within care while developing their invention on the side whereas others redirected their work completely to developing the invention. To have contacts within care facilitated the testing of prototypes.

Some inventions addressed problems related to women’s bodies. These female inventors developed their inventions within existing small firms or start-ups of their own. The problems that were addressed stem from the private rather than the professional sphere. Women does not necessarily invent exclusively for other women, their inventions can also be solutions to problems that humans in general may encounter in various situations.

Some of the inventions presented in this chapter, the ones from industry in particular, address partial problems in a systems context. The immediate users of this kind of inventions are internal users from other parts of the system. External users encounter the entire system as an integrated product rather than the invention that addresses a specific partial problem. Knowledge about the end use of the integrated product may however still be important in the development of the partial invention.
Inventions also address problems of external users, problems whereof some are specifically related to women. Some inventions address problems related to women’s work, in this case different kinds of care work. In these cases the users are both the nursing personnel, who in contemporary Sweden most often are women, and their clients - in this case disabled children, very sick patients, demented patients or bed bound women. Other inventions address problems directly related to the female body; in this case both its anatomy and its functions. Here the users are women - in this case peeing, incontinent, menstruating, nursing or sporting women. The inventions address problems related to various kinds of human activities as well as to human bodies. Since both human activities and human bodies are gendered so are often the inventions too.

Here we move on from what these specific examples of inventions have revealed about what is invented, in what context and for whom as the perspective hereafter is twisted towards the general processes through which gender and technology are shaped.
VI Women’s Processes of Invention

In this chapter the process of invention is outlined and discussed, building on empirical data collected via in-depth interviews with female inventors. The questions addressed have to do with how new technologies come to exist, what inventing women do, why do they do it, and how other people, things and knowledge become involved.

The process of invention takes its beginning in some context where the inventor becomes aware of a problem. Knowing about the problem is however not enough; the inventor must have some reason to engage in solving it, some reason to care enough to engage. Once engaged the inventor does however envision alternatives to ‘what is’ searching for ‘what should be’, building on the knowledge and experiences she possesses. Once envisioned the idea of an alternative way to arrange reality must be transferred from idea to matter. Here follows a process of trial and error, of testing and evaluating until a sufficing solution is achieved. A quote that captures the main features of the process of invention as it emerged in the inventor’s narratives follows here.

“Like any technology, the prototype does not work on its own, but as part of a dynamic assemblage of interests, fantasies and practical actions, out of which new socio-material arrangements arise.” (Suchman, Trigg, and Blomberg, 2002:175)

In the process of invention an inventor takes an interest in some aspect of the real world which s/he does not find satisfactory - a problem - and formulates it sufficiently clear to enable associations which make ideas of alternatives which may improve the situation visible - possible solutions - followed by the actions needed to realize a new solution.

An informant from care fingered an important cultural difference between care and development work. “Within care one must do it right the first time, otherwise someone may die.” She describes how she initially found the “trial and error” character of development work with its constant testing, making mistakes and correcting errors very unfamiliar. There was no single best way to do things but rather many possible optional ways, which meant that choices had to be made all the time. This image of invention fits well with Simon’s image of creative processes in general (Simon 1996).

Seeing Problems as Opportunities

Invention begins in the real world or in representations thereof where an insight in some kind of problem is achieved and the problem is turned into an opportunity by someone who cares enough to engage in solving the problem.
When I asked inventors to tell me about the invention at hand and the idea behind it they began by telling me about how they became aware of the problem that their invention offers a solution to, something that in many cases happened a long time prior to when the actual idea of a solution was generated.

The insight in a problem from which to generate an idea of a solution is often achieved via first or second hand experiences of some kind. The insight in a problem can be grounded in personal experiences like for Carin who found it uncomfortable that her breasts bounced during sports activities or Stephanie who was annoyed at buttons falling off her clothes at inconvenient times or Desirée who was fed up at repeatedly having her big bag fall off her bike.

Problems do not have to be experienced in first hand. The insight in a problem can also build on an awareness of other peoples’ problems. In Mia’s case it was when her sister had a son that she gained insight in a problem that up until then had been unknown to her: the exposed situation of nursing mothers. In Carola’s Case it was the fatal fall of her mother in law when she was going to the toilet at night that gave her insight in a problem which is common to many older women: the need to pee often and the risks and disadvantages it causes.

The insight in a problem can, like in Mia’s and Carola’s case, build on an awareness of a problem of someone near and dear. But the insight can also be about experiences of unknown persons, with whom one has no personal relations. Birgit has many inventions that solve problems of her own or of persons close to her, many of them related to her great interest in sailing. At least one of Birgit’s inventions is however unrelated to her personal experiences. In this case Birgit gained a general insight in the problem that chimney sweepers face a high risk of falling while sweeping high chimneys, something she with her engineering background understood could be easily avoided. In this case Birgit addressed a problem related to work, but not her own work.

Others have addressed problems that they themselves have experienced at work. In Kerstin’s case it was her experience from the habilitation of gravely disabled children which made her aware of the lack of working material that could be adjusted to the needs of children with different handicaps. In Monica’s case it was her experience from the care of demented patients that made her aware of the problems that occurred when they tore of their diapers. In Inga’s case it was her experience from the care of very sick patients that made her aware of the lack of appropriate working equipment for separating the clean from the dirty.

Within industry the problems to solve are often selected based on consumer demands and inventors are often given partial problems to solve, problems that have been defined by others within the frame of the technological system within which the company operates and as part of their product development. Hence it
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is not necessarily the inventor who experiences and defines the partial problem to solve. Inventors from industry are often given such partial problems to solve. They do have knowledge and experience from their respective fields to draw on. Inventors within industry may also have personal experience of using solutions to the problems addressed in industrial research and development.

According to Emma invention within industry is about solving partial problems alone or in teams. It is about improving existing solutions or finding new ways of using already known solutions. It is rarely about radical inventions. Problems to solve are selected in relation to what the customers want and what the competitors do. Christina and Alva tell me that product areas set the limits for what kind of problems they address.

Invention during processes of product development also takes place outside of industry within small firms. An example is Anu who wanted a new lamp for her shop. She wanted a drop shaped glass lamp with a closed bottom as opposed to the common solution with an open bottom. The problem she encountered in this product development process was how to suspend the drop shaped glass lamp and at the same time get the source of light inside it. Hence her invention addressed a partial problem and had to be integrated with other partial solutions to form the end product.

In Margareta’s case she was given the task to use an existing prototype of a urine bottle as a point of departure from which to develop a functional product for bed bound women. Margareta who had experience and knowledge from working as a midwife knew that such an invention was needed and could envision the necessary adaptations. Margareta was presented with the problem and an existing ruff solution of the problem at the outset, not unlike the starting point for inventors within industry.

The inventor’s strategies include constant efforts to see opportunities in the problems that are encountered. In the informant’s narratives the process of innovation is described in terms of constant problem solving well beyond initial invention. In order to realize an invention many kinds of problems have to be solved. Problems are seen as opportunities of improvement and even if the problems are difficult they are still seen as possible to handle. As one informant put it, “The impossible just takes more time”. Another informant tells me that she sees negative experiences as useful lessons.

This more or less conscious strategy to always look for opportunities in problems is present in the stories of all informants. In a sense they also use this strategy to turn the negative in being an exception to the positive of being unique and the visibility it entails.
Caring Enough to Engage

An important aspect of invention is what kind of problems that are addressed by invention, which has to do with how one comes to care enough about a problem to engage in solving it. For some a simple explanation is that it is part of their work, it is what they are expected to do. This is particularly the case for inventors from within industry, who of course may find other reasons to engage too.

For many inventors problem solving seem to be an alluring intellectual challenge that they engage in for the fun of it or for the satisfaction they feel when the problem is solved. The problem can also be seen as a social challenge, an opportunity to improve the situation for the users. Many of the interviewed inventors explicitly finger care for the users as central in their inventive work. Some of the female inventors focus in particular on those who can’t articulate their own needs, like e.g. the gravely ill, the demented, or the mentally disabled children.

Since women often are expected to care more than men it is perhaps no coincidence that many of the informants articulate care for the users. An adaptation to such gendered expectations is sometimes discussed in terms of a caring rationality as opposed to a less empathic technical rationality (see e.g. Gunnarsson, Andersson, Westberg 1998). It is however problematic if we expect care from women and not from men since it naturalises care as a trait of femininity rather than a choice open to men as well.

Invention can also be seen as an economic challenge, an opportunity to make money and achieve autonomy. This aspect often becomes more apparent when an invention is commercialized.

Envisioning ‘What Should Be’

Invention originates when an insight in a problem is accompanied by a vision of a possible solution. The insight in a problem is often something the inventor dwells upon for some time before the idea of a solution is generated.

The idea may however sometimes come like a “flash from a clear sky”, like in Desirées case when her irritation with the bag falling of the carrier of her bike made her formulate the problem in terms of “why do carriers have to be so small” followed by a sudden vision of a solution where the carrier could be broadened when needed.

In other cases the problem is twisted and turned around, related to knowledge about existing technical solutions of other problems and discussed with trusted persons. This way the inventor looks upon it from many different perspectives in search of possible solutions. Often many ideas are tried and evaluated before
Representing the Problem

An insight in a problem does not always result in an invention. We all encounter problems but unlike inventors we don’t necessarily attempt to solve them. By formulating the problem as clearly as possible its functional nature is unveiled, as are possible alternative solutions.

In Inga’s case the idea was an answer to a problem she had experienced when working at a nursing home for the elderly: the difficulty to separate the clean from the dirty material in the care of very sick patients. The lack of functional space for doing this work made Inga envision some kind of mobile working table or trolley which simplified separation of the clean and the dirty.

Kerstin and Else-My wanted some new working materials that they could use in their work with gravely disabled children. They discussed many ideas before they got the idea of making a rocking horse that could be specially adapted to the varying needs of the children they worked with. That the children had varying needs made it crucial to be able to adjust the rocking horse to the needs of each individual child. They also wanted to add as many variations as possible in order to make it a stimulating experience for children with varying disabilities.

In Birgit’s case problems were often noticed during everyday life but the ideas of solutions usually popped up in her head some time after that when she was doing something completely different like walking in the woods or at night.

According to Emma the problems to solve are defined through systemization, which she describes as a kind of structuring of the project by reflecting on and formulating the problem. After a problem has been defined, ideas can come from anyone in the group.

According to Christina and Alva their inventive work is about identifying consumer problems or needs and turning them into solutions. They try to see needs before the consumer does but they sometimes take their point of departure in user demands. Market investigations and customer surveys play important roles in their work of interpreting and transforming user problems into product solutions. Materials and interplay between materials give the wanted functions.

Recognizing Alternatives

By representing the problem as clearly as possible alternative solutions become increasingly visible.
In Carin’s case a twisting and turning of the problem went on for quite some time as she searched for a solution of the problem with bouncing breasts. Neither existing bras nor bandaging or surgery could do the trick. In Stephanie’s case the problem with loose buttons had annoyed her for some time when she got her idea. Anu kept the glass globe at her coffee table for a year and looked at it during every coffee break before she got the idea.

According to Emma the solution of partial problems also includes closer examination of the phenomena to master. Experiments are done in order to gain knowledge and insights that may be used in the solution.

Learning, research and knowledge production are important parts of Victoria’s inventive work. She thinks that it is important not to limit thinking too much initially even though laws and other considerations decide whether or not an idea will be developed. A group from the company makes judgments about if an idea can be realized, if it will be profitable enough or if it is of importance to claim a field. Customers also get to judge new ideas. Knowledge from judgment goes to product planning and thereafter to the developers.

Reassembling a Solution

Even though invention sometimes is described as a sudden flash of lightning the process does not really start with a sudden idea out of nowhere. The idea is rather something that emerges when particular experiences or insights are combined with some kind of knowledge.

Birgit has no strategy for what she invents but her knowledge in technology has been a resource in the process, often combined with her experience from sailing. Birgit always lets new ideas rest for some months. If she still finds the ideas interesting after that she takes them further, otherwise they end up in the bin.

In Carin’s case it was the creative combination of the insight in the problem with an insight in materials technology that gave her the idea that finally solved her problem. In a fabric shop she found a material which was elastic in one direction and inelastic in the other. The encounter with this material made Carin realize that a bra sewn out of this anisotropic material could give her the wanted combination of vertical support and horizontal flexibility.

In Stephanie’s case it was knowledge about an existing technical solution of another problem that in combination with the insight in the problem of loose buttons gave her the idea that solved her problem. Stephanie had used cable ties to gather and attach the cords of stereo equipment. She realized that a somewhat modified cable tie probably could be used to in a fast and easy way attach loose buttons.
The weekend before Anu got her idea; she and her partner had been taking down threes and removing them. In this work they had used a gripping device, which opens over the trunk when it is moved down over it and grips the trunk when lifted. A few days later Anu sits at her coffee table and does that movement of the gripping device with her hand over the glass globe and suddenly the idea comes. “This is the way to do it”.

According to Emma invention involves quite a lot of investigative work, search for information and making use of existing knowledge. Invention is about borrowing solutions from other fields or about finding new combinations of old solutions. It often involves rescaling of known solutions or turning them around somehow. Sometimes Emma can get useful associations when reading something and that she finds inspiration in her kids’ toys, like e.g. playstation and remote controlled cars.

An idea in terms of an envisioned solution to a problem seems to build upon a synthesis of some knowledge about or experience of the problem at hand and knowledge about technology. A broad base of experiences and knowledge about technology can hence be seen as a rich source from which creative combinations of great originality can be generated. Profound knowledge may give more sophisticated ideas of solutions. The vision of a possible solution does however have to be materialized as a working solution in order to become an invention in practice.

Materializing the Envisioned

Many of us have ideas about how to solve various problems but often we don’t do much with our ideas. But it is not until ideas are realized that they become inventions in practice. In this process abstract ideas have to be translated into concrete tangible artefacts or processes that work in practice. It is a process where abstract ideas are given useful form and content. Communication with others about the invention is facilitated when the idea is transformed to a more concrete form; like sketches, drawings or models. To begin with the idea is often visualized in simple sketches or in models which are successively tested and modified before stabilizing in some kind of prototype that in its turn may be submitted to further testing. In some cases prototypes were subjected to extensive testing in order to evaluate their functionality. Positive test results sometimes resulted in demand from those who had participated in the tests and were often used in marketing.

Anu soon realized that she could make a simple prototype in order to see if her idea of a suspension for the lamp worked the way she believed it would. Out of an old clothes hanger of steel wire she bent the first prototype which turned out to work just as anticipated. Then she understood that the idea could be valuable.
“Oh, I may have come up with something good.” After that she showed her suspension device under a secrecy agreement to a small manufacturing company that does aluminium parts for a large company and they made a very nice prototype for her.

Carin had ideas about how the sports bra should be designed stored in her head. When she wanted to make a prototype for testing she contacted many firms that sewed sports clothes, but none of them was interested even though she offered them the exclusive right to her business idea. “All I spoke to were men and they had never heard of a sports bra. Who was interested in such a thing? They claimed there was no market for that kind of clothes.” Finally, after much hesitation, one of the manufacturers agreed to sew a sports bra for Carin. When she met the people who were to sew her bra she used simple sketches to explain how she wanted them to sew the bra. In order to make it fit well and give stable support without sliding broad straps and a sturdy back side was needed. Carin wanted it to have a nice design and delicious colours so that the user would not want to hide it.

Birgit’s working experience made it easy for her to make a prototype of her first invention, the device for wet sanding since she had become a specialist in finding odd materials and in performing tests. She built and tested the prototype herself and it worked as she wanted it to. She made the first device for her own use without any intention of commercializing it but the reactions from others who saw her using it that made her realize that there was a demand for such a product.

Carola’s idea was initially concretized through a lot of cutting and pasting where thick paper was strapped around wooden blocks and the paper potty was dipped in paraffin in order to be able to perform tests, i.e. pee in it. Carola searched for information about peeing back in history and in other cultures that could be useful in product development. Even though people most certainly must have solved peeing related problems in many ways back in history Carola found little documentation of such things to build upon.

Desirée’s first step towards realizing her idea was to attend an inventor’s education. During this education she learned how ideas could be concretized as prototypes and also had the opportunity to practise her newfound knowledge on her own idea. She built six different models out of cardboard before she found the one she eventually came to use.

Monica turned to her sister Anne-Marie for help when she wanted to make the first prototype since she had a sewing machine and sewing as a hobby. In the first attempt they sewed together a t-shirt and underpants for men and put elastic at the waist. Monica brought the garment to work and tested it on patients and it turned out to work well. Monica and Anne-Marie discussed how the garment
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should be designed and which materials were suitable a lot. Through her working experience Monica knew how the garment would be used and Anne-Marie knew a lot about different materials and sewing techniques. They sewed three different successively improved prototypes that were all tested on patients and turned out to work very well. After the tests the extra staff who had worked night at Monica’s work wanted to buy the night wear to their regular workplaces.

Inga made the first sketches of the working table on wheels herself. Later she hired an engineer who did the first “real” drawing. She needed help from a workshop in order to visualise her idea further, but the workshops she contacted showed no interest in her idea. Via an adviser she finally got in touch with a workshop that could help her. It took about a year to produce the first prototype. The second prototype was made by another producer. It took a lot of time to produce the prototypes. Inga has tested three working tables in care work and the response from the users was positive and the working table was seen as an improvement of the working environment as well as of aspects of hygiene. The users also gave comments and suggestions of changes that were of great use in the development process.

Mia sewed the first prototype of the nursing top herself. She also drew the sketches needed for the patent application but she hired a patent attorney to write the text. Mia’s sister, who was nursing her son at the time, did the initial tests. She did not do any more extensive test before ordering the first series, but now they do tests all the time.

According to Emma the concretisation of ideas is about writing, drawing, and structuring. Hardware is often designed before software and may hence need modification in order to fit with the software. Hardware is usually patented. Software is difficult to protect with patent. It is difficult to know if software is new or not. Prototypes go through function tests. In order to get feedback prototypes are sometimes shown to customers under mutual secrecy agreements. First Office Applications is when benevolent customers get a free trial but in return have to put up with “children’s diseases” of the product to be. Normally it is smaller details that have to be adjusted. Product development has a lot to do with e.g. produceability and compliance with laws. The inventors do not have to solve these kinds of problems, but they have contacts with those who do.

According to Emma solutions of partial problems have to be synthesized into an over all solution. In order to avoid too much divergence between the groups technology coordination is used. Ideas that do not fit in the project can be steered to the right place, within or outside of the company.
According to Victoria concretization means that her partial solution has to be adapted to the product as a whole. In this adaptation negative functions have to be avoided. The result must be mostly positive. Today concretization is often outsourced to subcontractors, which can be a disadvantage since misunderstandings may be more difficult to straighten out. Long term cooperation does however lead to very integrated work.

According to Christina and Alva the generation of ideas for inventions only is a small part of their work and that most of their work has to do with visualisation of ideas as prototypes. Within the company they have a prototype centre where they can make initial simple prototypes that can be tested by users in focus groups.

**Testing the Materialized Vision**

The materialized visions must be evaluated through tests, something many informants had a lot to tell about. Some examples of what the tests could involve follow here.

When Carin could try the first prototype it turned out to work exactly as anticipated. It kept the breasts in place during gym classes and it looked great. Women she met in the locker rooms asked her what she wore. Carin has had elite athletes testing her stuff and giving their opinions. Apart from that Carin, her friends, and employees have tested the bras in use and washed them over and over in order to check how the fabric could take wash and wear. She has used the test results to improve the products. To have a concrete bra to demonstrate in stead of only an abstract idea also turned out to be crucial later on when Carin was to sell her sports bra to the retailers.

Kerstin describes the materialization of the rocking horse as a process of gradual development where i.e. supports were tested on many occasions in order to fit children with different handicaps so that they could sit strapped on it. Kerstin tells me that strapping was needed since “… some of them are very afraid of sitting on something unstable.” Hence, they developed a solution that could be adapted to children with different handicaps. They also painted the horse with anti-slide colour and used different kinds of rugs in order to stimulate the children’s feet, which could vary in sensitivity. In addition the horse had a resonance plate on which different things could be placed for sensory stimulation. They lent the rocking horse to different work places in order to test that it worked. It turned out to work very well and became very popular among those who tested it.

Margareta had an existing prototype of a urine bottle as a point of departure when she had a simple test series of twenty bottles manufactured that were subjected to extensive tests and the test results informed development. Initially
it was Margareta herself, her friends and her mother who tested the urine bottle. As the bottle turned out to be too high Margareta had the test bottles cut in different heights that were tested. Margareta also used her contacts within care. During a period of six months patients and personnel participated in extensive tests of the urine bottle. When a survey showed that 85 % of the users were satisfied with the urine bottle she dared manufacture a cheap tool for production. The shape of the urine bottle was a result of all the tests that were done. When it came to the choice of material Margareta chose the same plastic material as was used in the existing urine bottle for men. This way the urine bottle was adapted to use by bed bound women as well as to production.

As illustrated by the examples above materialized ideas often undergo tests in order to judge if they improve the situation enough, if further adjustments will be sufficient or if an alternative path should be taken. In practice this is often an iterative process where prototypes are tested and adjusted to the guiding idea, which in its turn also may be adjusted to a more realistic form based on insights from the process.

**Commercializing**

Inventions are often both commercialized and patented. Even though this thesis focuses on invention rather than commercialization and patenting, these subjects are discussed briefly as they are part of what the informants told me that cannot always easily be cut off.

Many but not all inventions are commercialized. The reason for patenting an invention is that new technologies and their creators are not automatically protected by copyright, like e.g. artists and their work are. To obtain a similar exclusive right to an invention the inventor has to apply for and be granted a patent. Hence, many inventors do patent their inventions in order to make sure that they have the legal right to commercialize them. Large industrial firms often have patent departments of their own that handle the patenting of inventions developed within the company. Independent inventors may turn to patent attorneys for assistance with the patenting of their inventions.

Sometimes inventors do however not patent their inventions. The reasons for not patenting vary. According to the interviewed inventors from within industry a lot of what is invented within industry has to do with gradual improvements of existing solutions rather than something radically new and is never patented even though industrial companies encourage patenting.

The inventors from outside of industry have other reasons for not patenting. Lack of knowledge about the patenting demand of novelty, which means that the invention has to be kept secret until the patent application is made public, can make patenting impossible if the invention is revealed to the public before
applying for a patent. To show the invention at a fair or to a journalist who writes about it can make patenting impossible. This is a mistake that it is easy for someone who is not familiar with patenting to make, which the case is for many inventors outside of industry the first time around. Industrial companies with patent departments of their own are on the other hand well aware of this and their work with inventions is often surrounded by secrecy.

To patent an invention may also be quite costly. The informants tell me that costs in the realm of several hundred thousand SEK are not uncommon. Industrial firms take these costs into account in the process. Inventors outside of industry often find patenting quite costly. For some inventors this means that patenting is no option. Others use their savings or mortgage their homes in order to afford patenting. Those who choose not to patent sometimes use alternative means of protecting their inventions, like e.g. design protection or trade mark, since these are less costly.

What separated the study of women’s patented invention from women’s invention in practice was not only women’s classified inventions which were not included in the study but also all the inventions that women for various reasons never patented.

**Inventing for Need and Demand**

As we have seen invention addresses issues related to user need as well as to consumer demand. Invention within industry does normally take place within the framing of customer demand. This does not mean that issues related to user needs are absent however. An inventor may be given a particular problem to solve, with the main focus on achieving a well functioning solution. If the solution turns out to bee too expensive it may not be realized though. Industry sometimes engages in developing visionary inventions too. The main focus in these processes is not to make money in a short perspective but rather to learn and thus make it possible to come up with good ideas in the future.

Inventors outside of industry focus a lot on meeting user needs, something which as the innovation process proceeds moves more towards customer demands. It is not a good idea to make things that no one wants to buy, at least not if you depend on it to make a living, which is normally the case for the inventors. Sometimes they invent while still working with something else on the side. This makes them less dependent on making money from their inventive activity, but also limits the time available for it.

No matter if the problems addressed by invention relate to user needs or customer demands the inventors engage in the process of invention for different reasons. For some it is just part of their everyday work, it is what they do to make a living. For others it is the intellectual challenge that draws them into
EMPIRICAL ASSEMBLAGES

doing it. Yet others answer to the social challenge in meeting the needs of others. Sometimes the financial challenge and the opportunity to get control over ones time and to be able to fill it with what one wants is what attract the inventors. Their reasons to engage in solving problems are often combined.

Once engaged they use their knowledge and experiences to represent the problem so that it can be solved, and to find alternative ways of doing it. Here the ability to recognize what is needed and to combine relevant information is crucial. When a solution is envisioned it has to be transformed into material form in order to exist in the real world as an invention. Drawings, models, prototypes are made and tested. Tests are evaluated and prototypes adjusted. This is an iterative proves that goes on until a sufficing solution of the problem is achieved.

Sometimes it takes expensive tools to produce a prototype of an invention, which brings financial issues into the image earlier in the process than otherwise. Hence, it is difficult to separate the process of invention from the process of innovation within which it normally takes place.
VII The Gendering of Women’s Invention

In this chapter the perspective is twisted towards the other one of the two main foci of this study, which is gender. The informants’ narratives do not only address the process of technological creativity through invention but also a closely related creative process in which the gendered character of invention is not only encountered but also adapted to and sometimes challenged. Hence, the gendered character of invention becomes an additional problem for the inventors to find a working - or sufficing (Simon 1996) - solution to during the process of invention. The questions addressed here have to do with how gender is intertwined with technology in the culture and practice of invention, what problems and opportunities this entail and what strategies female inventors employ to succeed.

The gendered character of invention becomes visible in the informants’ narratives in terms of references to a reoccurring masculine imagery of invention and other technology related concepts as well as to experiences from an often male dominated practice.

**A Masculine Imagery**

During the time I have spent studying women’s technological creativity it has become clear that there is a strong gender bias in the understanding of who may be an actor in relation to technology and of technology itself. The informants often refer to and comment a masculine imagery of invention and other technology related concepts, which is exemplified here with images of ‘the inventor’ and of ‘technology’ itself as masculine.

As the image of ‘the inventor’ emerged and stabilized it turned out to encompass three main actor roles in the shaping of technology, see figure 1.

![Figure 1: A Masculine Image of ‘the Inventor’](image-url)
In the image of ‘the inventor’ two poles can be distinguished: the madman and the genius. In the madman direction we find the ‘Gyro Gearloose’ type of inventor, the eccentric male nerd who spends most of his time producing strange curiosities which no one really needs or wants and who hence rarely becomes commercially successful. This disrespectful image of the inventor is something independent inventors outside of industry tell me that they often have encountered and also express a need to dissociate from.

In the genius direction we find two successful categories, the researcher and the innovator. The researcher appears as the ‘Nobel laureate’ type of successful researcher. This image is often applied to inventors at the research and development departments of large industrial firms or university laboratories, who seem to be respected and seen as the origin of technoscientific development.

The innovator on the other hand appears as the ‘industrial manager’ type, like those in the group of men who founded many of the existing large industrial firms in Sweden based on some invention, in many cases about 100 years ago. Here we find for instance Alfred Nobel who founded Bofors. Paradoxically it seems to have been forgotten that men like Alfred Nobel once started their businesses at a modest scale. Their glory seems to be reflected on the top management of large industrial firms rather than on the entrepreneurs who are starting companies based on new inventions today. The entrepreneur hence becomes somewhat obscured in the image of the inventor and even banished from the genius side. Some time has however past since the interviews in this study were performed and since then ‘the entrepreneur’ has entered the limelight of public discourse and actually become a contemporary ideal. This has probably moved the entrepreneur away from the nerd towards the successful innovator.

The image of ‘the inventor’ that emerges in the informants narratives is clearly gendered. ‘The inventor’ is always a man, whether a nerd, a scientist, or an industrial manager. The only woman who seems to be generally acknowledged as an inventor is Marie Curie, who is seen as an ingenious researcher kind of inventor. Other female inventors, the Swedish ones included, are however still more or less invisible in the imagery of invention, despite media’s increased

17 The inventor duck Gyro Gearloose is one of the duck characters in Carl Barks comic books and cartoons about Donald Duck. In Sweden he is called Uppfinnar-Jocke and his name is very much present in Swedish contemporary cultural understandings of the inventor.
interest in the subject. No woman inventor has become well known enough to influence the general image of the inventor. We have our Håkan Lans, but no female equivalent. Perhaps it takes two Nobel prices for a woman to be acknowledged as a ‘real’ inventor? The masculine imagery is not only one of ‘the inventor’ as a man but also one of ‘technology’ as related to men’s work primarily with steel and machines in an industrial context (see also Udén 2000). When the inventor is a woman she may however be expected to invent something feminine. The images of the inventor and of technology do always refer to men and their fields of activity unless combined with the epithet ‘woman’ in some form. The masculine imagery presented above is something inventing women refer to and that many of them find it difficult to identify with without modification.

A Discriminating Practice

Even though women are almost entirely excluded from the masculine image of invention there are women who invent in practice, like the informants of this study. The content of the black box of technology is not as homogenous as one could expect (see e.g. Latour 1993). Even though women do invent in practice they describe this practice as often dominated by men. Invention takes place in relation to a multitude of actors, of whom many turned out to be men, see figure 2.

![Diagram of Actors of Invention](image)

**Figure 2:** Actors of Invention
The informants refer to many different actors who in one way or another are involved in the innovation process. Many of these actors are however more involved in the commercialization of the invention rather than in the process of invention. To begin with it is normally the inventor’s family, friends and colleagues who are involved in the process of invention. The inventor often turns to some kind of advisor too. Sometimes actors like manufacturers and financiers are involved not only in commercialization but also in the materialization of the prototype.

Many of the informants tell me that they initially had insufficient networks for the innovation process, something many key informants confirm. One key informant expresses it like this. “Women don’t have the friend with a workshop, technological expertise or knowledge about materials. Men have this support around them naturally.”

When the informants tell me about their networks an image of a dynamic and changing structure emerges. With a point of departure in their existing networks they seek contact with other relevant actors. It is often men who have the information that leads the inventors to actors of importance. Among family and friends it is often men like e.g. the informants’ sons, husbands, brothers or fathers who have contributed with contacts and access to capital or technological expertise. “My brother … helped me with the technical drawings. / … / He helped me because I cannot draw and he is a technician so he could do it for me.” Men do not only provide contacts or knowledge but are also often actors of importance like advisors, financiers, manufacturers, retailers, mentors and consultants.

Women in the family or among friends or colleagues have also participated, but often in other ways than men. Women are often involved in user tests of the invention at the prototype stage and beyond.

Roughly men dominate the innovation process, in particular on the technical and financial side. Women constitute a minority among the actors in the innovation process and are found primarily on the market- and customer side but also as exceptions on the technology side. More women are however involved in the commercialization of inventions than in the actual process of invention. Hence, the process of invention emerges as even more male dominated than the innovation process of which it is a part.

Women may however be of importance in the process of invention in other ways than the informants refer to. A lot of what is seen as women’s work is often taken for granted and not really noted. That employees within care of e.g. children and the elderly, who are often women, do work which makes it possible for others to work elsewhere is well known today. Many of the informants did however not have any children who needed childcare. Some of
them had no children at all. Some tell me that they had chosen not to have any children since they saw children as incompatible with the lifestyle they had chosen by becoming inventors.

To be a woman has both advantages and disadvantages in the context of invention. Women as inventors are encouraged, respected and admired but also meet resistance, despise and envy. Many informants tell me that there are few who at all understand what they do, particularly among women but also among men. Women who invent do something that is uncommon even among men, but particularly so among women.

Many informants tell me that they met a lot of scepticism and questioning to begin with followed by admiration or envy if the started to become successful. One informant expresses it this way. “In the beginning everyone thought I was crazy, later they thought it was great.” Another informant tells me that she met a lot of scepticism when she became an inventor compared to when she had worked with research. Yet another informant tells me that she was not taken seriously as an inventor and that her work was seen as some kind of funny hobby rather than serious business.

Many informants stress the importance of networks for female inventors. In these networks they find an understanding for what it can be like to be a woman in a male dominated context, sometimes having to combine invention with family responsibilities. Advice which they receive from members of such networks is seen as more realistic than advice from men who don’t have to take responsibility for a family. One informant comment the different working conditions of women and men this way. “There are always women who take care of that which men don’t do.” The opposite seems to be uncommon, even though one of the informants tells me that her husband actually takes care of domestic work since he has retired.

**Negotiating Space for Women’s Invention**

The informants do not only refer to the gendered character of invention, they also give accounts of ways of adapting to and sometimes challenging both the masculine imagery and the male dominated practice of invention. These women have to negotiate some space of action where they may pursue their inventive activities.

**Humanizing the Imagery of Invention**

When it comes to the imagery of invention many of the inventors hesitated to identify themselves as inventors even though they had invented. This was particularly the case when it came to those who were in the early stages of the
innovation process. Among inventors in the early stages comments like “I’m no inventor, I have just done this little thing” were not uncommon.

Even though the informants who were interviewed more in depth have more experience from inventing - they have all invented something and many of them have even patented their inventions - they were still quite ambivalent in relation to being an inventor. Even though they were quite clear about that they were inventing they still hesitated to identify themselves as inventors. They often emphasized a more nuanced image where the inventor is allowed to be an “ordinary person” rather than the extremes of the madman or the genius. This goes for those who have invented in industrial research and development as well as for those who have invented outside of industry.

Victoria from Vehicle Engineering Inc. tells me that she does not feel like an inventor even though she has invented “but it is fun to be part of three patents.” She tells me that the concept of inventor makes her think of ‘Gyro Gearloose’. She tells me that her grandfather actually calls himself an inventor sometimes and that he has been her role-model. “He has challenged me by saying that there is no one in the family that takes after him. That I studied engineering meant nothing to him, but now he is proud of me.”

Neither does Emma from InfoCom Tech Inc. consider herself to be a “real inventor” even though she has three patented inventions, one which she invented individually and two as part of a group. The kind of invention she has done she sees more like “an ordinary job”. Today she has moved upstream from invention and she sees it as unlikely that she will invent again. She is still part of the process but she does not do solutions herself anymore. She is rather involved in the reformulation of problems. To have some patented inventions and the experience of invention does however give status in the professional role in terms of recognition as a good developer. But “real inventors” are for her those who work full time inventing really unique and radically new things, which she tells me is rarely the case when it comes to industrial research and development. Much of the invention that takes place in research and development at InfoCom Tech Inc. is rather about improvements or new ways of applying a known technological solution, e.g. solutions that have become cheaper and possible to use. She contrasts with research laboratories at the universities that work for longer periods with problem solving and may come up with radical inventions. Even though most people in research and development work with what she calls “ordinary invention” they do sometimes come up with good and patentable new solutions. She tells me that the more difficult problems often are given to inventors that are known to bee good and that it is only those who have contributed a lot to an invention that are named in a patent.
Christina and Alva from Intimate Innovations Inc. also express ambivalence in relation to being an ‘inventor’. They refer to themselves as product developers or development people rather than inventors even though they also acknowledge that they do invent. “I guess we see ourselves as inventors without calling us that”. They see the concept of ‘inventor’ as most appropriate for those who have received patents, particularly as independent entrepreneurs.

Even though the informants from within industry acknowledged that they did invent they still hesitated to identify themselves as inventors. The informants from outside of industry were also ambivalent to identifying themselves as inventors. ‘The inventor’ was for many of the informants either a madman or a genius whereas they referred to themselves as “ordinary people”. No one wanted to identify with the madman, the nerd, who invents weird and useless things. The genius was more like a role model, a beacon to strive for, rather than something they expected to achieve.

One informant tells me that she does not call herself inventor even though she sees herself as one. Another informant tells me that she actually feels like an inventor but that she most of the time solves problems of her own. “But I am not one of those who engineer a lot of machines. I do however have a rather good ability to find good solutions with simple means. Like how to fit a nursing table in to the smallest space in the world. But I can not always realize everything by myself.”

Some informants do however refer to themselves as inventors, but not without reservation. They emphasize that they are no ‘Gyro Gearlose’ type of inventors. One informant tells me that she is proud to be able to call herself both inventor and innovator, to have managed to bring her idea all the way to a new product. “But I am no ‘Gyro Gearloose’.” She tells me that she thinks that it is more accepted to be an inventor today than before.

Some of my informants tell me that the way they title themselves has changed over time as they have gained increased self confidence as inventors. “To begin with I did not see myself as an inventor, even though it was what I did.” One informant tells me how disrespectful treatment for some time made her refrain from calling herself inventor. “It was [disrespectful] like that, even among members of the parliament you know! I started to wonder then, so I stopped [calling myself an inventor]…” She tells me that she now refers to herself as an inventor again. “When people ask me now - since three or four years back when it suddenly became OK to be an inventor - I say it if it fits, if it is like a feather in the hat. I don’t say it if I expect them to bring out a ‘Gyro Gearloose’ or so, because that is the worst thing I know.”

Many informants use a strategy where they emphasize different aspects of the inventor identity. Some find the initial creative phase most interesting rather
than production and sales. Others find the challenge of getting the product out on the market and of getting the idea to pay off economically as the most stimulating parts of the process. In other words, some identify more with inventor traits closer to the researcher while others identify more with the innovator or the entrepreneur.

Some prefer to call themselves innovators, sometimes even if they have not yet reached the market with their invention. They find the concept of the innovator more up to date and less negatively charged than that of the inventor. Many informants also express dreams of becoming successful innovators. They often dream of being able to make a living on, and perhaps make some money on, inventing and developing inventions into products. They often also want to achieve independence as entrepreneurs, to become their own bosses. These are dreams which some of the informants have been able to realise.

Others prefer to use their previous professional title. Many of the informants have chosen a complementary strategy where they see themselves as inventors but just as much as something else. It is often a professional identity from before they became inventors that they stick to because it is of relevance for their inventive work. One informant tells me that she does not like titles, but that she has the title of the profession she was trained to on her business card in order to show where she comes from. Even though she does not normally refer to herself as an inventor she expresses pride in being one. “I am more proud of being an inventor than of being a managing director, to have given something to other people.” Those who have not invented something related to the previous profession are less inclined to stick to the previous professional identity.

The informant inventors outside of industry acknowledge that they do invent and they are actually more inclined to call themselves inventors than the ones from within industry. They do however identify with an alternative image of the inventor than the dominant one, a modified image which they have created in order to make ordinary people and women fit in.

As described above it is not uncommon that the informants title themselves in many different ways, depending on the situation. This is something many of the key informants have commented on too. One informant comments on why inventors prefer to call themselves innovators. “The concept of the inventor they see as being about inventing the wheel or gunpowder or something equally advanced. Innovator is understood as more neutral, as less value laden. They don’t think they belong either in the world of ‘Gyro Gearloose’ or in the world of Alfred Nobel.” Another key informant says that “inventors are mostly older men, rarely women. The inventor is an unfortunate concept which neither women nor younger persons relate to. Innovator is better. Product developer is a better concept, it says more.” Another key informant tells me that “women are
more humble in the earlier stages, they do not want to call themselves anything in particular. Before, it used to be bad or ridiculous to be an inventor. They preferred to call themselves product developers. Men find it easier to call themselves inventors. But, the attitudes in society have changed. Now, invention is almost a cult.” One of the informants tells me that she tries to influence the understanding of the concept of the inventor by emphasizing the concept and its importance in contexts that she believes may be of importance for invention in general. According to her there has been a change in the way inventors are looked upon during the last few years. “It is society’s view of invention that has changed.” According to her there have been more resources for spreading information about invention during the last years than before. “It is TV shows [Svenska ljus] and all sorts of things that has not been there before.” Yet another key informant remarks that “there are not so many who want to call themselves inventors among women. Inventors are associated with the traditional ‘Gyro Gearloose’. Many women, but men also, prefer to call themselves innovators, product developers or researchers. I think it is more common that men call themselves inventors.” One key informant claims that “before, there were many who did not want to call themselves inventors. Inventors of the de Laval or Nobel character invoked too much respect. The nerd in the basement they could not identify with. Today it is in vogue to be creative. I see no negative charge in calling oneself inventor today. There are also more girls who call themselves inventors today.”

The experiences expressed by the informant inventors (whether they see themselves as inventors or not) are confirmed by the comments on the subject made by the key informants, who are in positions where they have knowledge about inventors in general, or female inventors in particular, as a collective.

**Women Aspiring to be Human**

When it comes to making unconventional choices, like becoming an inventor, role-models can be of importance. The almost complete absence of women in the image of ‘the inventor’ reflects a lack of role models for women as actors in the shaping of technology. The informants who had role models of importance for their choice to engage in invention almost exclusively had men as role models. The role models vary from the Renaissance man Leonardo da Vinci to some inventive or creative man among celebrities, relatives or friends.

One of the informants tells me that she has had a role model in her mentor, who is also an inventor and who has become rich on his products. Another informant tells me about a person who has become a combined role model and mentor for her. “My first husband, who I am divorced from, is an entrepreneur and inventor. He has been there as a discussion partner.” One of the informants from industry has had a role model in her grand father, who sometimes calls
himself an inventor. “He has challenged me by saying that there is no one in the family who takes over after me. Then I studied engineering, but it did not impress on him. He is proud of me now, though.”

One informant differs from the others in that she has a woman as role model, namely her entrepreneurial mother.

That inventing women often have men as role models may seem odd, but it offers an opportunity to transcend the limits gendered structures of society set for us as individual actors. When there are no female role models it is quite reasonable that women chose men as human role models.

Female inventors challenge common cultural expectations and social practice which meets varying reactions. Many of the inventors from outside of industry do not feel respected and taken seriously. In many cases the strategy to solve this problem has been to use a secret weapon - men. When other actors don’t treat them as professionals they use men as a kind of “Trojan horses” for the best of the project. Sometimes men were brought to meetings as support and as witnesses. One informant tells me that manufacturers often turned to her husband in the discussions. When they have a man and a woman to choose from the man seems to be expected to be the inventor and the woman some kind of assistant. The sorting mechanism that places women and men as sub- and superordinated seems to be at work in this context to.

In a way these women have adapted to a prejudiced context by giving up their position as actors to men. This can be seen as a clever move through which they still control the game unseen. The question is if they really could have made a different choice and still succeeded. That men are used in this way indicates that there is prejudice and discrimination on the innovation arena.

**Women Reclaiming Technology**

Many of the interviewed inventors spontaneously address the connection between gender and technology, even though they do not use the academic concept gender. One informant expresses it in the following manner: “I don’t understand why so many people persist in seeing different things as male or female. To carpenter or sew is only about different tools.” What she said made me reflect on the meaning of the concept of technology within engineering educations. How is it that courses treat subjects like metallic or polymer material but not textile material and various seams? Have these parts of technology been excluded since they are considered feminine? From a principal perspective one would expect knowledge about materials to include all kinds of materials, textiles included, and all different ways of bringing parts together, seams included. This is however not the case. Sewing is however present in some informants narratives about invention as a technical, creative
and enjoyable activity. “Sewing became more like a technical construction. It was about fibres, threads, and seams more technically.”

Another informant tells me that she used to sew her own clothes and redesign clothes as a teenager. In her case creativity was canalized to other materials - like metal, nuts and bolts - in relation to invention. The material changed but the process remained the same.

Some informants talk about technology as joyful. One of them tells about this unexpected insight. “I discovered that technology was fun. Cooperation with the factory gave wonderful new experiences. Before, my work used to be more diffuse. Now it is concrete, real.” The informants focus on the positive side of technology - its opportunities - rather than its negative side - its risks.

**From Masculine Notion to Human Practice**

A paradoxical insight from my contacts with inventors was that many women invent without identifying as an inventor in the conventional sense since the dominant cultural image of ‘the inventor’ turned out to be an image in which women and ordinary people do not fit in. The conventional concept of ‘the inventor’ does seem to be considered too nerdy to identify with without reservation by most of the inventing women. But they still take pride in that they have invented. The dominant image of the inventor is that of either a madman or a genius, but no matter which always a man. Hence, my study confirms that the concept of ‘the inventor’ has a masculine bias in a Swedish context just as previous research has shown in a North-American context.

The somewhat one-sided emphasis on large established companies rather than small start-up companies as the source of technological creativity leads to an equally one-sided emphasis on conservative rather than radical innovations (see e.g. Latour 2005). The form of innovation which hence becomes visible as important is the incremental improvements of existing technological systems rather than radical innovations which characterize entirely new technological systems. Perhaps this reflects that new companies built around a radical invention meet more resistance than those who have once succeeded and continue to improve a known concept. The innovations which stand out as important are about improvements within the framework of existing technological systems. The image of new technology hence turns out to be a conservative one, aiming at preserving existing fields of technology which are to a large extent equivalent with those of men.

The informants describe themselves more as “ordinary people”, neither the eccentric nerds nor the remarkable geniuses they see as part of the conventional inventor identity. The informants explicitly dissociate themselves from the nerd, who they neither can nor want to identify with. Those who refer to
themselves as inventors emphasize the genius side of the concept, which relates to the researcher or the innovator, but at the same time stress that they are more like ordinary rather than exceptional people. The unwillingness to stand out as exceptional can be seen as a trait of conventional femininity which tends to exclude women who are too successful. It can also be seen as a product of the Swedish cultural imperative to be ‘lagom’, which means ‘medium’ or ‘not too much and not too little’, a kind of balanced compromise position.

Some relate the inventor to the entrepreneur as an innovator, even though entrepreneurial inventors often are considered to be more on the nerd side of the inventor concept by others - something many of my informants have experienced.

In my encounters with inventors I have also met men who express a similar ambivalence towards identifying as inventors, which implies that neither all men are attracted by the image of the male nerd which seems to be an integral part of the conventional understanding of the concept of ‘the inventor’.
CONCLUDING DISCUSSION
VIII Women’s Invention

In this the concluding part of the thesis the different threads of the study are drawn together in a discussion of theoretical insights. The empirically grounded theoretical insights from this study are summarized and integrated with selected theoretical perspectives, hence forming a tentative theory of women’s invention.

The image of invention that becomes visible in this study consists of the synthesized impression of many partial fragments with particular foci on gender and technology. The tentative theory which is presented here is formed by synthesizing the empirically grounded conceptual assemblages of such fragments from the previous chapters with a selection of theoretical concepts and perspectives.

As humans making a living on earth we have to relate not only to the material facts of the real world, including our own existence, but also to the dominant ideas about its and our own nature. Material reality can be seen as embedded in ideas about its nature, ideas that are constructed by humans as are often the material reality they refer to (see e.g. Haraway 1991). Hence, we can be seen as both products and producers of our conditions (see e.g. Arendt). Invention occurs when a seed of novelty enters these processes. Radically new ideas may lead to paradigm shifts allowing new ways of understanding the world and, if implemented, alter the assemblage of systems and processes in the world - the world itself. Change does however often appear to be of an incremental rather than a radical character. Such non-spectacular step-by-step changes are often left unnoticed, which may explain the emphasis on reproduction rather than on creativity in social studies (see e.g. McNay 2000). If we look only for radical and revolutionary change much invention will remain unseen, which has been the case for much of women’s invention, particularly when related to small improvements in everyday life (see e.g. Stanley 1993).

When we experience the real world through our senses - sometimes enhanced by technology (Haraway 1991) - we find ourselves in a stream of impressions that has to be interpreted and structured somehow, often in a hierarchic manner (Simon 1996), in order to make any sense to us. This is something humans have struggled with for long and that has resulted in systems of ideas about the world of e.g. religious, philosophical or scientific character. Even though science has claimed to provide valid representations of the world this has not always been the case. Feminist studies have shown that science to a large extent has been biased by beliefs about gender in which women and men are seen as binary opposites (see e.g. Fausto-Sterling 1985 and 2000). One example is the belief that men by nature are technologically competent whereas women are not. This
CONCLUDING DISCUSSION

may be an explanation as to why women’s invention has remained almost entirely invisible in mainstream studies of invention - few expected such a phenomenon to exist.

To study women’s invention implies a simultaneous focus on the origin of invention in terms of women as inventors, on their processes of invention, and on the outcome of these processes in terms of women’s inventions.

Agents of Invention

Invention can be understood both as an individual and a collective endeavour. Hannah Arendt sees invention as the solitary work through which Homo Faber generates ideas and gives them material existence (Arendt 1998). Herbert Simon sees the generation of ideas as a cognitive process that involves recognition, which takes place within the individual psyche (Simon 1996). The inventors often describe how the insight in how a problem can be solved comes after having become aware of the problem in question, often after having dwelled upon it for some time. The idea may come as an almost immediate flash of lightning or after some time of reflecting on the problem. Perhaps it is the cognitive aspect of invention, that ideas are generated within our minds, that make theoreticians otherwise inclined to look upon human action as interaction to emphasize the solitary character of it.

The inventor becomes visible as someone who creatively combines insights in problems with knowledge about possible solutions in theory and practice in order to generate ideas of something new to make manifest as a prototype invention. The insight in a problem is often related to a context of use whereas knowledge about possible technical solutions often is related to the context of technology, to engineering design. Women constitute a minority among engineers and even more so among professional inventors but are often users of technology within women’s fields of work. Never the less the study of patent registers reveals that Swedish women have invented at least since 1885. The study also makes it possible to present not only a minimum figure of how many female inventors there have been in Sweden but also the number and percentage relative to men of their patented inventions, se table 12.
CONCLUDING DISCUSSION

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<td>–</td>
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</tr>
<tr>
<td>1991 – 1998</td>
<td>512</td>
<td>716</td>
<td>4.3</td>
</tr>
<tr>
<td>Total</td>
<td>675</td>
<td>922</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Table 12  Female inventors and patents by female inventors in absolute numbers and relative to men

From 1885 to 1929 a total of 163 women are named as applicant-inventors in 206 or 3.7% of the patents. From 1930 to 1990 women can not be identified in the patent registers due to an extensive use of initials instead of full first names. Known female inventors can however be identified in the registers. From 1991 to 1998 a total of 512 women are named as inventors in 716 or 4.3% of the patents. During the whole period studied, 1885 – 1998, a total of 675 women are named as inventors in 922 or 4.1% of the patents. Data from the patent registers reveal that there have been at least 675 female inventors in Sweden up until 1998. If we assume that women kept inventing as they had done before the period from 1930 to 1929 about 300 additional female inventors may be added leading to the number of approximately 1000 female inventors during the period from 1885 to 1998.

Even though many women invent and there has been a significant increase in the number of patented inventions by women during the last century the percentage relative to men does however remain low, about five percent. The situation seems to be the same in other western countries. Patented invention has increased but the gender gap remains unchanged, something that is a bit astonishing considering that Swedish society has changed a lot during the 20th century to become one of the most gender equal countries in the world (see e.g. http://www.weforum.org/pdf/gendergap/report 2007.pdf.). During this period women have gained access to higher education in technology and hence also to occupations within technological industries, something that may explain the increase in the numbers of patents by female inventors. The invention related gender gap does however not seem to have been influenced much by this change. The percentage of women may even be higher during the former period.
than during the 1990s since female inventors though improbable still may be hidden behind the initials of inventors in patents owned by organizations.

The insight that women were just as likely to invent in a society that refused women many basic human rights as in the democratic society of today raises many questions. Maybe women were more inclined to participate in the shaping of technology during the late 19th century and the early 20th century, which was a period when the ways in which society was structured according to e.g. gender or class was being challenged by the emerging women’s and worker’s movements. If so, the unchanged percentage of women among inventors during the 1990s indicates that women have become less inclined to participate in the shaping of technology relative to men even though they have gained access to relevant education and employments.

The extreme male dominance of invention means that women to a large extent still are excluded from the shaping of new technologies and the social contexts in which they are embedded – also known as the sociotechnical. If I allow myself to borrow the inventors’ strategy of turning problems into opportunities the lack of women among inventors can be interpreted as a potential for increased participation of women in the creative processes of invention and innovation.

**Invention as Part of the Innovation Process**

As mentioned in the introduction the concept of technology is used in a broad sense referring to products, processes and related knowledge as well as to their organizational contexts. The concept of invention is used to refer to the creative process through which new technologies are generated by developing ideas into something real that works well enough to be useful in practice. The concept of innovation is used to refer not merely to the process through which an invention is turned into a commercial product but to the overall process through which an idea is developed into a product on the market.

Out of the informants’ narratives emerges an image of invention as often - but not always - situated within the larger context of innovation both from a process and a systems perspective. Invention relates to innovation in the way that without invention there can be no innovation, but there can be invention without innovation. Inventors sometimes invent for their own use without any intention of commercializing the invention. Many do however from the outset strive to fit invention into the market economy logic of contemporary society, in other words they strive to make a living on it by commercializing their inventions. They do this by working with inventing either as employed or as entrepreneurs. No matter if invention takes place within larger industrial firms or within smaller start-up firms it is hence a part of the commercial innovation
process. Invention within these contexts can be seen as related not only to utility but also to necessity since inventors just like almost everybody else have to make a living on what they do (see Arendt 1998).

Invention becomes visible as the initial part of the innovation process, see figure 3.

Figure 3: Invention as part of the innovation process.

The processes of invention and innovation both start in some kind of problem. The problem may occur within different contexts, end user contexts as well as industrial or entrepreneurial producer contexts. From an insight in an existing problem an abstract idea of a solution is generated which in its turn is concretized in some kind of prototype that solves the initial problem for the inventor. If commercialized the prototype is turned into a product on the market which when used may offer a solution of the initial problem to many. The innovation process may, but does not have to, follow this order. For various reasons there are sometimes relapses in the innovation process, which is of a trial-and-error character. Something is tested and if it goes well one proceeds and if not something new is tested. Apart from that additional invention often occurs during the product development process, which involves a great deal of reoccurring problem solving.

Invention can be seen as the situated doing - reflection and action - through which inventors generate ideas of something new and makes them manifest in the real world as prototype inventions (see e.g. Suchman 1987; Alonso and Simon 1993). The process of invention as described in figure 3 above consists
of three main processes: engaging with ‘what is’ the problem, the envisioning of ‘what should be’ the solution, and the materialization of the envisioned solution into a working solution - an invention as a working prototype. Sometimes inventions are more about processes than products but they still need to be concretized and tested in real life. These processes are often reiterated until a sufficing rather than an optimal solution is generated (see Simon 1996).

When it comes to how problems become selected to solve, inventors within industrial contexts are given partial problems to solve as part of their job. Inventors outside of industry on the other hand selects the problems to solve on their own often based on an attraction to the problem as an intellectual, social or financial challenge. The intellectual challenge is met for the fun of it and the satisfaction when one succeeds. The social challenge is addressed when the inventors care for and a wish to improve the situation for the users, who sometimes are unable to care for themselves. The financial challenge is addressed when the inventors want to achieve financial autonomy and freedom of action for them selves. It is often a mixture of these aspects that motivates the inventor to engage with solving a problem.

The ideas of solutions build upon a synthesis of general or specialized knowledge about technology and use. Knowledge about technology can be e.g. knowledge about principles of function, properties of materials, or methods of production stored in our memory (see e.g. Simon 1996). It is less common that women have an inner library about technology (Aurell 2000). Knowledge about use can be knowledge about the context and practice of use, which is often achieved via presence in these user contexts. The inventors generally combine insights about technology and use, which sometimes are grounded in expertise and sometimes parts of their general knowledge. Some of the inventors have a technical education and/or related experiences which provide a solid base for new ideas. Those who don’t have a technical education often enrol persons with the needed competence in the process of invention. Others have an education in e.g. care work and/or long term experiences thereof which give them a solid understanding of the user side.

The idea of a solution is turned into a working prototype through an iterative process where prototypes undergo tests and subsequent alterations hence becoming increasingly sophisticated until considered sufficing (Simon 1996). Users are often involved in the process of evaluating the prototype inventions. The informants also describe how the envisioned solution is materialized. Sometimes they manage to make a working prototype themselves whereas in other cases the inventors involved others in the making of the prototypes. Hence, idea generation can be an individual endeavour but may also involve
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others. The realization of the idea of a solution can sometimes be done by the inventor herself but does often involve other actors.

Even though the primary focus in this study is upon the process of invention and not on the following parts of the innovation process that has to do with commercialization including production on a larger scale, it is important to remember that invention often takes place within a commercial context. Sometimes when it takes large investments just to produce a working prototype of an invention this becomes obvious. In other cases, when a prototype of the invention can be produced without large costs, economic considerations do not really enter the narratives before the inventors refers to more costly parts of the innovation process like e.g. large scale production or protection of the right to commercialize the invention via patenting.

That the emphasis during the process of invention often is on user need whereas the emphasis during the later stages of the innovation process or when it comes to invention within industry is more on customer demand indicates that commercial aspects become increasingly more important as the innovation process proceeds. User need and customer demand may, but do not always, coincide. Users do not always have the resources to demand what they need. Hence a successful invention in the sense that it solves the problem and is just what the user needs still requires customer demand in order to become a successful innovation.

Invention within Systems or Networks

The process of invention emerges not only as an individual doing but also as a generation of new technical solutions to various problems and a doing of gender related thereto that involves a system or network of actors or an apparatus of bodily production (e.g. Haraway 1991; Latour 2005). The image of invention is an image of something humans do that both relates to and challenges the ways in which reality is understood and organized in a specific context. The doing of technology and gender becomes visible as intertwined parts of the process through which a new system is created, improved and finally destroyed, see figure 4.
Inventions that do not fit within existing systems contexts may initiate entrepreneurial creation of entirely new systems, which may be the case for spin offs from industry or other organizational contexts – like care providing organizations in this study – as well as inventions from outside of industry. Such emerging systems or actor networks (see e.g. Latour 2005) which are created to produce new technologies are initially relatively informal, flexible and dynamic. The goal is to make the enrolled actors of the system or network intra-act, act as one, in order to succeed (Barad 2007).

The opportunity to create more egalitarian systems is sometimes used but often traditions, conventions and a general unawareness seem to prevail in the ways systems are gendered. That many inventors enrol both women and men in their networks can be seen as a reflection of their wish to see invention as something human rather than exclusively male, which would have excluded themselves to begin with. That they often choose men as experts in technology does also have to do with an understanding of that men are met with more respect than women as agents in the innovation process. To enrol men is quite rational to do in order to achieve success on a gendered arena but at the same time the female inventors hereby contribute to their own subordination. It can be seen as an
CONCLUDING DISCUSSION

adjustment these women do to overcome the obstacles raised by a discriminating practice.

Inventions may also serve to improve an existing system, which is often the case when it comes to inventions from industrial contexts. In such a context invention often addresses parts of the system that lag behind, the so called ‘reverse salients’ (Hughes 1987) or ‘dynamic imbalances’ (Callon 1991), and is often about incremental improvements rather than something radically new that would not fit in. Focus is on maintaining and improving the system, something that requires administration. A formal organization and contracts keep the system relatively stable and inventions are often patented for increased predictability and control. There is however a risk that an established system becomes too static and hence organizational change is sometimes used to make it more dynamic and adaptable to a changing environment. In order to facilitate creative processes in an established system special techniques, like e.g. brainstorming, are used to create a free and informal space within a regulated and formal structure. Gender issues are often addressed within existing systems that in one way or another lag behind when it comes to gender. Hence action may improve but not change the system radically from a gender perspective since the way the system is gendered to begin with is part of the system.

Competition between existing systems and the emergence of radically new systems also make systems break down as they become obsolete, something Schumpeter (1942) referred to in terms of creative destruction. The breakdown of an existing system is not necessarily a bad thing since the parts the system consists of become available for new innovative processes (see e.g. Fridh 2002). For some of the interviewed inventors it was actually unemployment that gave them the opportunity to engage in the development of their inventive ideas. Hence, the breakdown of existing systems presents innovative opportunities in terms of new technologies as well as of new potentially more inclusive ways of doing gender related thereto.

Invention often takes place within an organizational context that stabilizes aggregates of actors/actants, like e.g. small entrepreneurial companies or large industrial companies. When it comes to entrepreneurial start-ups, it is not only the invention but also the organization needed for its realization that is created and subsequently stabilized. When it comes to established industrial companies, invention takes place within the boundaries of an existing stabilized system. Most of women’s patented invention takes place within industrial organizations. With increased complexity invention takes place within contexts consisting of aggregates of individual and organizational actors. Innovation systems are example of such more network-like constellations in which many individual and organizational actors are aligned to intra-act for innovation (see e.g. Barad
Innovative Opportunities

Together with the insights from the study of patent registers the study of examples of women’s invention from some different contexts revealed innovative opportunities. In some cases the inventions solve problems related to care work. Despite the fact that we all, at least during some periods of life and to a varying extent, depend on the care of others independence has for long been an ideal in western society.

Care can be seen as part of the labour of necessity which is needed to maintain life itself, something that since antiquity has been considered suitable for women but something free men preferred to have nothing to do with (see Arendt 1958). From being something that back in time normally was carried out in the home, often by female members of the family, care has become professionalized and moved into work places which normally are dominated by women (see e.g. Wærness 1983 and 1989). Hence, women are more likely than men to have first hand experience of care work. If one takes a closer look at the patent registers it becomes evident that inventions related to care work are few and that these generally are invented outside of the public health and care organizations.

The insight in a problem related to care work is often achieved by the people who do this kind of work, who in contemporary western society often are women and also increasingly immigrant men. They have experience from working with people with special needs such as the young, the elderly, the ill or the disabled. With an ageing population, in Sweden as in many western countries, demand for health and care services can be expected to increase. In order to meet this increased demand an increase in productivity is needed, something which implies that innovation will be necessary. Hence, the integration of knowledge from the practice of care work in the assemblages of knowledge upon which the new technologies of tomorrow are founded becomes yet an innovative opportunity. The problem of the relative lack of innovation within care work can also be seen as a business opportunity where unaddressed problems are waiting for solutions in terms of new products or work processes.

In some cases women’s inventions solve problems related to the human body and its functions, which can be seen as the centre of gravity of our understandings of gender. Biological gender, or sex, is often understood as a
natural dichotomy where man and woman are constructed as opposites, despite
great variations within the categories (see e.g. Fausto-Sterling 1985 and 2000).
Even though all women do not share the same experiences of their bodies, some
phenomena are generally understood as more or less exclusively female. Some
problems occur in relation to female body functions like those of menstruating
and breast feeding. Other problems occur in relation to human body functions
such as for instance urinating, where anatomical differences and social practices
still may pose gender specific problems. Gender aware knowledge about bodies
and their functions as well as about body related practices may also present
innovative opportunities.

In yet some cases women’s inventions solve problems which are neither
exclusively related to the female body nor to work places dominated by women.
In these cases the inventors build upon knowledge which is probably seen more
as gender neutral, even though it very well may be knowledge from male
dominated fields of practice. To give more women the opportunity to profess
such knowledge and to participate in the process of invention would also
present innovative opportunities.

Inventions

The inventions, the actual outcome of invention, become visible through the
study of patent registers. The patent registers reveal that many of women’s
inventions from the period around 1900 were individual inventions related to
problems that women often met in their private everyday lives but women’s
inventions were also related to e.g. weapons, mechanics, electro technology,
vehicles, and chemistry. In the 1990s women’s inventions had changed
character to most often be collective inventions of gender mixed groups related
to mainstream technology within an industrial context and only a small part
were individual inventions solving everyday problems in private life.

Even though much of women’s invention has relocated from the private to the
professional sphere during the last century it has maintained a great variety
beyond what is normally seen as feminine, indicating that women’s invention
addresses human issues - feminine one’s included.

Women’s inventions appear to reflect the contexts in which they were invented
rather than the contexts of women in general. During the period from 1885 to
1929 women’s inventions often, not without exceptions though, reflect
problems of a personal or domestic character that had little to do with
established industrial firms. On the other hand most of women’s inventions
during the 1990s had the character of conventional technology in the sense that
they reflect industrial problems whereas inventions of a personal or domestic
character where the exceptions. Today the patented inventions of Swedish
CONCLUDING DISCUSSION

women reflect their presence within industrial research and development more than the contexts of Swedish women in general. If the latter had been the case most of Swedish women’s invention would have been related to health and care, which is not the case. Hence women’s inventions have changed from reflecting problems women encountered outside of industry during the period from 1885 to 1929 to most often reflecting industrial problems during the 1990s. Outside of industry the private household seems to have offered more opportunities to invent than the public health and care organizations.

A Narrow and Excluding Norm of Invention

The inventors often refer to and problematize a dominant cultural understanding of invention as masculine, something that has been in focus of feminist technology studies to. It is a limited symbolic understanding of invention in which the main actor of invention, the inventor, is seen as a man who normally invents for other men. This notion of invention can be seen as an overly simplified image of Swedish reality, where most - but certainly not all - inventors are men. That most - but not all - inventors, if seen to patented invention, solve problems defined within the technological systems of an industry that employs mostly men and that often have other industrial firms as customers can be one explanation of the notion of invention as something men do for other men. That the understanding of technology in itself often is reduced to the artefacts, activities and fields of knowledge of men makes it kind of obvious that new technology is seen as invented for men.

The notion of invention as masculine effectively hides not only female inventors but also inventions somehow intended for women. This may be one explanation to why for long those who studied the shaping of technology showed little interest in female inventors or women’s sphere technologies and why those who studied gender or women tended to overlook invention as part of women’s experience.

The dominant cultural understanding of the shaping of new technology through invention as masculine tends to make it difficult to see not only new technology as sprung out of women’s experiences but also women as actors in the shaping of new technology, see figure 5 below.
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<table>
<thead>
<tr>
<th>Sectors</th>
<th>Dominated by women</th>
<th>Dominated by men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>Visible as technology</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Obscured and visible actors and sectors of technology and invention (Modified version from Nyberg 2002).

Just like technology has become almost invisible within sectors of society that are considered to be feminine, like e.g. care work which is dominated by women, women have also become almost invisible as actors within sectors of society that are considered masculine, e.g. technology in the conventional sense which is dominated by men. The study at hand has cast light upon women’s invention within sectors that are dominated by men as well as sectors that are dominated by women and has hence contributed to broadening the understanding of technology. Men who invent within sectors of society that are dominated by women are also in the shadow of the dominant understanding of technology and invention. They are however not included in this study.

Invention Within and Beyond the Norm

The dominant cultural understanding of invention as masculine makes it problematic for many of the informants to identify as an inventor without comment. Most of them in one way or another refer to the dominant cultural image of e.g. the inventor, invention or technology and adjust it in order to make it include themselves and their inventions. The image of the inventor as someone exceptional, a genius or a madman but always a man, was transformed into the inventor as an ordinary human being. The notion of new technology as masculine was transformed to new technology period.

Even though the informants through the adjustment of the dominant cultural image of invention manage to see themselves as inventors, and often are proud of being it too, they are sometimes not recognized as inventors by others. In some cases they give accounts of having been treated with disrespect by men,
as someone automatically expected to be in a subordinate position with little to with the invention.

The context in which the idea of an invention is materialized is often a male dominated one. Industrial research and development departments are often male dominated, but there are exceptions. Inventors outside of industry develop their ideas into working prototypes in contexts that they themselves create for that purpose by enrolling different kinds of actors to their actor networks. Men are often enrolled for their knowledge in e.g. technology or production but sometimes also just because they are men. Women are often involved in the testing of prototypes since they often have knowledge about the contexts and processes of use.

Invention becomes visible both as a quite stereotypical masculine notion but also as a much more complex and indeterminate human practice where the doing of gender is entangled with the doing of new technology in many different ways. The relative lack of women among inventors and of inventions within women’s fields of practice can be seen as both a problem and a hitherto unexploited innovative opportunity, a reverse salient of our national innovation system awaiting innovative efforts to solve the problem with gender related inefficiencies of the system.
IX Reflections from the Research Process

The research process did not only result in theoretical insights but also in methodological ones. In this chapter some methodological insights from the research process are summarized and reflected upon. Finally possible paths to explore in future studies are outlined by summarizing some of the paths that became visible but for different reasons were not followed in this study.

Research as a Creative Process

An insight that made me a bit confused about what I was doing was the many similarities between the research process and the process of invention. Just like my inventor informants I too had become aware of a problem in the real world - that invention is dominated by men and perceived as masculine. If I had been an inventor seeking to solve this problem an obvious solution would have been to add more female inventors and stir. Being a researcher I did however choose to problematize the phenomenon by focusing on the women who were already there.

Another similarity is that research just like invention can bee seen as taking place within a systems context - as being system bound or system building. To do a cross disciplinary study like this one is not something that fits well into ordinary academic disciplines. Hence, my task became not only to assemble some kind of research result but also to bring together what was needed in order to achieve this in terms of people with appropriate competencies and compatible agendas as well as other resources. But since the job had to be done within a formal academic context too, parts of it can bee seen as system bound. Hence, research has been carried out both within an informal actor-network and within the formal academic system.

Benefits and Shortcomings in Assuming a Hybrid Position

There are both benefits and shortcomings in assuming a hybrid position, which in my case is the intersection between gender and technology where feminist technology studies has emerged during the last decades and where the concept of technofeminism (Wajcman 2004) captures the intertwined character of gender and technology. A benefit of assuming such a position is that there are a lot of unanswered questions to address, which minimizes the risk of merely reproducing the work of others. A shortcoming is that the journey often is a solitary one where you sometimes have to map the terrain yourself as you enter it. Furthermore advice from colleagues belonging to the many disciplines where
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studies of gender and technology are done may sometimes be contradictory and confusing rather than clarifying and guiding.

To have a gender perspective in my research enabled me to see beyond what is taken for granted and often woke curiosity among the people I met outside of academia, who generally knew little about gender studies. To have a background in technology on the other hand facilitated my understanding of the subject and often gave me an increased credibility among the people I encountered in the process, but it was also sometimes met with suspicion by social scientists as if though a too close relation to technology was a negative thing. Of course the position from where one looks upon reality matters and enables us to see certain things but perhaps not others. If I would have been a pure social scientist my field of vision would probably not have been diffracted by technology related contaminations. But I cannot, and do not want to, erase my past. On the contrary find that it is my past that has allowed me to see similarities in theories about how gender and technology gets made, to see both gender and technology as inventions - as ideas that we integrate in the material assemblages in the real world bee it bodies or machines. Furthermore, to have experienced what an exceptional position similar to that of my informants can be like probably helped my informants relate to and trust me.

Evaluation of Research Results

Scientific work is often evaluated in terms of its contribution to knowledge production and the reliability and validity of its results. Via the focus on women’s invention actors, activities and artefacts otherwise excluded have been included in the study of technological change hence contributing to a widened understanding of the concepts of gender and technology and of the processes of their shaping.

I make no claims to present a complete or finished image of the subject, something that indeed would have exceeded the limitations of this (or any) study. I do however contribute with a multi-faceted contextualised vision that depending on how the lenses are organized provides a kaleidoscopic image or one distorted by interference (Moser 2006), an image that may be considered “thick” (Geertz 1973) as a result of my “being there” (Geertz 1988), an open-ended image allowing additions and alterations (Novotny et. al. 2001). The image I provide is constructed from inscriptions of passing events allowing never ending re-visits (Geertz 1973) but also completed by memory work (Widerberg 1999).

How can the results of this study be evaluated? Much of the work that takes place within academia plays important but rarely acknowledged roles within knowledge production. Supervision and seminars are examples of interactive
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processes in knowledge production serving as a kind of quality control where ones work is reviewed and discussed by colleagues aiming at discipline-bound peer-group consensus (Novotny et. al. 2001). Comprehensive accounts of how a study is carried out makes the results contestable and hence more trustworthy (Berner 1989). Access to committed and competent supervisors as well as active seminars has benefited and validated my research.

When the empirical material which this thesis builds upon was collected the main informants were given the opportunity to read and give me their opinions about what I have written in order to correct errors or misunderstandings. I have also presented my research to several different groups of inventors who have given me feed-back and opportunities to discuss my work. Furthermore I have discussed my work with smaller groups or individuals, inventors or others active within the field. Presenting my work to and discussing it with relevant actors can also bee seen as a way of testing its validity (Novotny et. al. 2001).

Future Studies

Apart from the main results of the study the research process did also reveal possible alternative paths to explore further, some of which I will elaborate a bit on here. The participation in invention related activities of the network for female members of the Swedish inventors’ Association is something that could be developed into a study of its own. The exploration of other invention related organizations could also be deepened in various ways, e.g. by studying the exhibitions of the National Museum of Science and Technology or the patenting process / organization of the Swedish Patent and Registration Office from a gender perspective. One could also seek ways of highlighting women in the patent registers during the period from 1930 to 1990, women who are at present hidden behind initials. Perhaps different kinds of filed documents can reveal the full names and hence gender of the inventors. Newspaper articles or other publications about women’s invention may also provide information that can make it possible to identify female inventors in the patent registers. Interviews could also be done with inventors from other contexts than in this study, such as e.g. inventors from universities, from particular industries or even innovation systems. Another option is to study women’s contributions to specific types of inventions.

I have chosen to build this study upon empirical material about women’s invention as a way of problematizing mainstream invention and broadening the understanding of technology. Men who invent within sectors of society that may be considered feminine are also in the shadow of the dominant understanding of invention. Hence, a focus on their experiences of invention is something that also could contribute to broadening the understanding of
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This is something that could be explored further building on the insights from research about men and masculinities.
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