CONTINUING EDUCATION CENTER

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Gender and Technology:

The 'Female Factor' in Software Design

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by

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Affidavit

I, **Henrike Stefanie Pätz**, hereby declare,

1. that I am the sole author of the present Master's Thesis *"Gender and Technology - The 'Female Factor' in Software Design"*, 131 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

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For Renate

Abstract

In the era of user-centered design several scholars have started to take a closer look at gender as one of the decisive factors for successful innovation. While technology, and specifically information technology (IT), has become the backbone of almost all industries and a key driver for innovation, women are still largely absent from these fields. They are heavily underrepresented as technology designers and neglected as autonomous users with individual needs. This thesis sets out to demonstrate the importance of gender for technology design; it analyzes the reasons for the lack of women in technology using a feminist perspective, and proposes a number of possible approaches how gender awareness could be increased in IT with a special focus on the organizational aspects of business software design. The findings are based on an in-depth literature review and are validated by means of several case studies of female IT professionals in the global software industry.

The demographic situation in the 21st century as well as the respective literature and research provide clear evidence of the social and economic benefits of increasing the 'female factor' in technology design. Women are a key – and heavily underused - driver for innovation, organizational performance and financial success in most companies. Yet, when analyzing the gendered nature of technology it became clear that its inherent masculinity has to a large extent been responsible for the absence and marginalization of women from IT until today. Current approaches to overcome the 'women-technology-dilemma' are often either seeking to help women adapt to the male norm or are over-emphasizing feminine connotated values for technology design. The findings in this thesis underline the social constructivist perspective that neither technology nor gender can be taken as fixed and given but are cultural processes subject to negotiations, contestations and transformation. As a consequence, one of the most important prerequisites for the software industry to make sure the results of their application design fit with the needs of a variety of stakeholders, including female users, is the establishment of a gender aware organizational mindset and a respective design framework using gender as a 'lens' and apply it every time new applications are being planned and implemented.

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List of Abbreviations

BMBF	-	German Federal Ministry for Education and Research
BMWi	-	German Federal Ministry for Economy
D.A.U.	-	Dumbest Assumable User
DDS	-	Digital City of Amsterdam (De Digitale Stad)
e.g.	-	for example
et al.	-	et alii
etc.	-	et cetera
EC	-	European Commission
ECWT	-	European Center for Women and Technology
EU	-	European Union
ibid.	-	ibidem
ICT	-	Information and Communication Technology
IST	-	Information Society Technology
IT	-	Information Technology
KPI	-	Key Performance Indicator
R&D	-	Research and Development
S&T	-	Science and Technology
STS	-	Science and Technology Studies
UI	-	User Interface
UN	-	United Nations
UNDP	-	United Nations Development Programme
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
US	-	United States
WSIS	-	World Summit on the Information Society

1. Introduction

"The first step toward change is awareness. The second step is acceptance."

Nathaniel Branden

This thesis is about gender awareness in technology design with a specific focus on IT and software applications. The problem background that inspired me to choose this subject is twofold:

Firstly, IT has become the backbone of almost all industries and is one of the most important drivers for innovation in the Western world (see e.g. European Commission 2011a; BMBF 2010; European Union 2010; BMWi 2007). Beyond its economic impact, IT is also one of the forces shaping society and the life of most individuals in the industrialized nations in an increasing fashion. Yet, in contrast to this pivotal role for (wo)mankind, women are still largely absent from technology and IT design and thus mainly excluded from shaping these new realities which I feel is problematic both from an democratic angle and with regard to the inevitably one-dimensional masculine perspective which gets reflected in the products. Given the fact that the success of an innovation depends upon its adoption by customers in the market (see e.g. Schumpeter [1934] 1982), and considering the role of users as key actors in the diffusion and acceptance of new technologies as pointed out by Eric von Hippel (1988) it is also an economic necessity to analyze and incorporate the needs of the major users groups when developing new technological solutions. Yet, while the number of women as autonomous customers of technology has significantly increased over the last decade their specific needs as users are still frequently neglected. Gender differences have been largely disregarded in technology research, design and innovation leading to products that often do not meet the needs of female target groups. A vivid example for this *"gender blindness"* in technology design mentioned by Schraudner/Lukoschat (2006, 3) is the case of early speech recognition systems in cars which did not work for most female voices. Annoying, but not perilous – but what about technology used in surgeries which has not been tested on female organisms, or airbag systems designed only for male bodies as the norm killing rather than protecting children and smaller women in the case of an accident, as pointed out by Rosser (2006, 15)?

And secondly, despite the surprisingly large body of – mainly feminist – literature on the topic of gender in the context of science and technology, research with regard to gender and ICT, and specifically relative to gender and software application design is scarce (see Bath et al. 2008, 828; Vendramin et al. 2001, 80; Wilson 2001, 355f). Working for a large global provider of standardized business software I am interested in figuring out whether gender aspects actually play a role in the organizational processes steering the design of these applications being used by millions of men and women on a daily basis in their jobs and businesses, and to what extent female IT professionals are integrated and can contribute to these processes.

1.1 Purpose and Research Questions

In the era of user-centered design some scholars have recently started to consider gender as one of the decisive factors for successful product design and innovation – both with regard to women as creators and as consumers (see e.g. Schraudner/Lukoschat 2006).

One key point of departure and interest is the wide-ranging discussion on the topic of gender and technology. There is a large and heterogeneous body of research and abundant literature including many publications on the relationship of Women and IT. One of the overarching themes is the gendered character of technology which is accused of having excluded women from becoming creators and designers of technology and for the masculine notion of technical artifacts and products which often do not reflect the requirements and preferences of female users. As described above, information technologies have an increasing impact on our daily lives. Sefyrin (2010a, 2) argues that IT design is shaping organizational, social and cultural practices and realities enabling certain activities while hampering others. Concerning the impact of IT on its users and vice versa, as discussed amongst others by Oudshoorn/Pinch (2003) and Oudshoorn et al. (2004), she claims that *"the design of information technology is also the design of users […] but users also configure IT"*. As a consequence, IT design is not neutral but has clear organizational and social consequences. In addition, designers and innovators of technological devices and applications often unconsciously construct representations of targeted users considering their own preferences and skills to be representative of those of the future users. These constructs serve as the basis for the production of technology scenarios which then reflect the interest and skills of their creators – mainly young, middle-class men – and

exclude women and other groups of under-represented users (see e.g. Rommes 2006). Given the fact that this masculine focus criticized by feminist scholars is sometimes implicitly applied even if women *do* form a major part of the development team it becomes absolutely clear that specific attention needs to be paid to the systematic consideration of gender aspects in technology design (Rommes et al. 2001).

Based on this problem background, and regarding the lack of related research in the area of business software design, I would like to explore the following questions in this thesis:

1. Why does gender play an important role for technology design in the 21st century?

2. Why can technology, and specifically IT, be referred to as 'gendered'? What are indicators for a masculine notion, and which approaches exist to overcome the 'women-technology dilemma'?

3. What are issues and potential approaches to achieving a greater level of gender awareness in the organization of software design and to involving more diverse and 'female' perspectives?

4. Are the gender issues explored in the theoretical part of this thesis reflected in the personal 'technology history' of female IT professionals, and to what extent is gender awareness integrated in the software industry today?

1.2 Motivation

As a woman, grown up in the 1970s and 1980s in Germany, I have benefitted largely from the continuous efforts generations of dauntless and fierce individuals – including my mother – have made to improve the situation of women, especially in the Western world. Most industrialized nations have managed to climb the first steps of Maslow's 'pyramid of needs' with regard to women's rights (see Maslow 1943). Thanks to these courageous ladies we can now take scientific education, voting rights, birth control, and the right to lead a self-determined life generally for granted. Besides the discussion around further social improvements, like e.g. more financial and organizational support for mothers, my generation is currently fighting for the next steps to be taken towards more respect, equality and self actualization in the working environment. These include topics like equal pay and career development, a fair share of women in leadership positions, and measures for a better work-life-balance.

With technology, and specifically IT, playing a key role in public and private life Wajcman's (2009, 150) assessment that *"women's identities, needs and priorities are configured together with digital technologies"* is a fundamental finding which clearly points to the importance of women's involvement in the process of IT design. I absolutely agree with her statement (ibid.) that

> *"Drawing more women into design [...] is not only an equal opportunity issue, but is also crucially about how the world we live in is shaped, and for whom."*

I am grateful to my mother for having broadened my mind on the topic of feminism and women's rights early on and to my employer SAP AG for providing me with the opportunity to participate in this MBA Program focusing on Entrepreneurship and Innovation. I am glad to have been given the possibility to combine related class content, e.g. on user-driven design, with new learning on feminist theories of technology and gender-awareness in product design, and to discuss the outcomes with some female IT professionals testing them against the realities in the organization of the development and design processes in the global software industry. With this I hope to be able to contribute a little piece to the big picture of understanding gender equality in the context of IT.

1.3 Disposition

This thesis is built up of six chapters. In the *Introduction*, I present the problem background, motivation, purpose and research questions along with the delimitations and a comprehensive overview of the core concepts of feminism, gender and science & technology as a basis for the further analysis, understanding and discussion in the text.

The following chapter two, *The Relevance of Gender for Technology Design*, points to the significance of increasing gender awareness in the context of technology research, design and development. I discuss recent literature and findings concerning the absence of women as important stakeholders of technology and delineate the social and economic importance of including gender as a key aspect into these processes.

Chapter three, *The Gendered Nature of Technology,* is the key chapter of this thesis. Here I take a closer look at the findings of – mainly European and American authors – over the last decades on how technology is gendered and why women are still largely underrepresented as creators & designers and neglected as users & consumers of technology using a feminist perspective. After discussing some of the most prominent feminist approaches to overcoming the women-technology gap, I specifically look into the field of gender relations in the context of Information Technology.

Chapter four, *Towards Gender Awareness in Software Design,* builds on these findings. I discuss additional literature and elaborate on issues and potential approaches to mitigate the phenomenon of gender blindness in the organization of IT design and to increase the 'female factor' in the creation of software applications.

In chapter five, *Reality Check: Gender and the Software Industry*, I introduce four case studies of female IT professionals. After addressing their personal 'technology history' I look at the extent to which gender awareness has been integrated in the organizational processes and teams steering the design of business software based on their individual experiences and share their recommendations for companies and women in the industry.

Chapter six, *Summary and Conclusions,* subsumes the theoretical and practical findings on how IT companies could implement 'gendered lenses' in order to increase the 'female factor' in their design processes and provides an outlook on potential further research questions.

1.4 Delimitations and Definitions

The focus of this thesis is on the intersection of engineering and technology design, gender, and feminist critiques of science and technology concentrating on the relation of women and technology, specifically in the IT and software industry. Due to the large and heterogeneous body of research in each of these areas which needs to be reviewed and analyzed in order to define potential approaches towards more gender awareness in IT design the emphasis of my work clearly lies on the literature analysis, followed by the evaluation and discussion of potential ways to improve the situation. In doing so, I will primarily look at the situation in the Western, First World countries. The respective findings will be enhanced and verified based on the case studies of a small group of female software engineers and designers. For this empirical portion, my work is delimitated by the individual perspectives, histories and experiences of these women.

Some of the major concepts which form the basis of this work are not only complex but also dealing with "*fluid and somewhat contentious terms*" (Fox et al. 2006, 5). In order to generate a joint level of understanding and avoid ambiguity as much as possible, I will provide an overview and explanation of several of these domains, list some of the key points of criticism and discussion, and define my personal interpretation and usage below.

1.4.1 **Feminism**

The term 'feminism' defies easy definition as it embraces a multiplicity of perspectives. In general, it refers to the analysis and alteration of the discrimination of women and to theories of political, social and economic equality of the sexes (see e.g. Thiessen 2008, 37ff). Or, as Harding (1986, 24) states: *"Feminism is a political movement for social change"*. Its origins roughly date back to the late 18th century and the context of the French Revolution. Early protagonists were Olympe de Gouges who got beheaded for declaring the rights of women and female citizens, or Mary Wollstonecraft publishing *"A Vindication for the Rights of Women"* (1796; see figure 1). Wollenstonecraft condemns the tyranny of men demanding a fair and moral society. Amongst others she makes the strong statement (ibid.) that

> "[...] *for all power inebriates weak men [...] its abuse proves that the more equality there is established among men, the more virtue and happiness will reign in society.*"

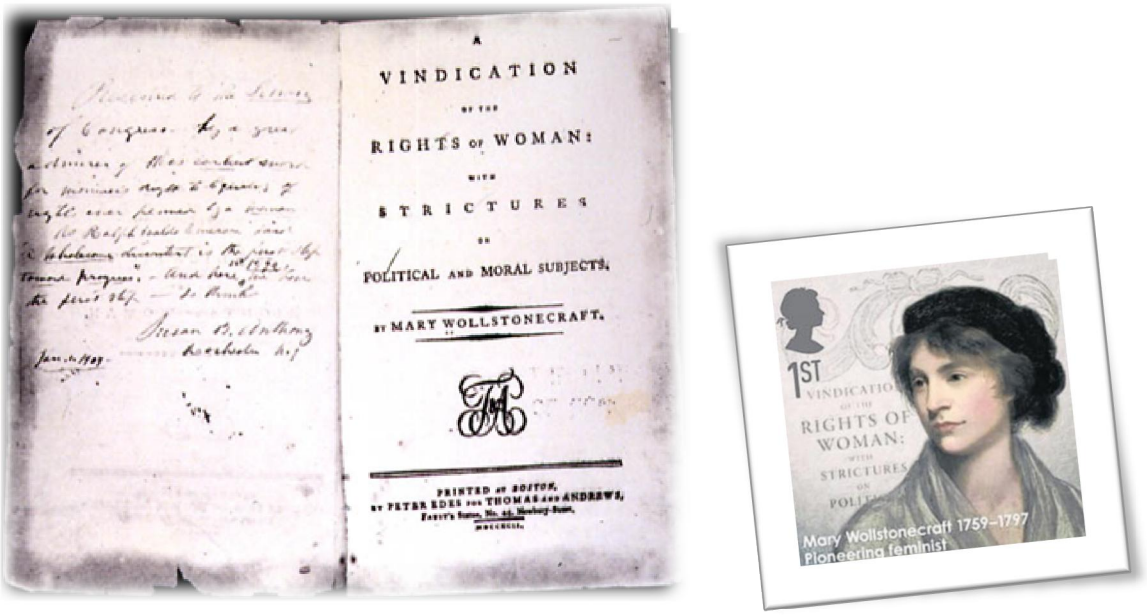


Figure 1: *Mary Wollenstonecraft – "A Vindication for the Rights of Women"*
Source: Google Images

Overall, feminism serves as an umbrella for a couple of heterogeneous concepts that are academically concentrated in the field of women's and gender studies encompassing different disciplines like history, economy, sociology, psychology, anthropology, philosophy, theology etc. The various schools of thought that have developed mainly from Europe and the United States can be distinguished according to their basic ideas, political motives, ideologies and target groups. One common starting point of all forms is the uprising against the marginalization and subordination of women as a group under the domination of men which run counter to the ideas of fairness and democracy. A key program of scientific feminism in the context of such unequal power relations is the analysis of *"binary oppositions as a structural principle of modern societies and basis for a hierarchical relationship between the sexes"* (Thiessen 2008, 37ff). Several authors have discussed the history of feminism (see e.g. Götsch 2010; Beck 2009; Holland-Cunz 2003), and I will outline some of the most important concepts and perspectives in a simplified manner in the following paragraphs.

1.4.1.1 Political Dimension

Major political movements are liberal, socialist and radical (autonomous) feminism. *Liberal feminism* came up in the second half of the 19th century mainly from within the middle-class demanding equal rights for women in politics and society – while keeping alive the traditional physical, psychological and traditional role differences and the ideal of the family as the major social institution. The *socialist feminists* basically saw the fight for the rights and the improvement of the social situation of working class women as one aspect in the overall quest for overcoming the class society. Recognizing that patriarchal structures are also dominant in socialist systems these ideas later turned towards a broader criticism of political structures. One stream includes the vision of (proletarian) men and women fighting together for equality and better living conditions; the other - *radical feminism* - refuses a mixed-sex approach trying to free all women from the patriarchal bonds and mechanisms of sexual suppressions which are said to be – explicitly or implicitly – supported and applied by most men (see. e.g. Millet 1971).

1.4.1.2 Ideological Dimension

On the ideological axis, the ideas mainly deal with different gender concepts. The three major streams are the *humanist-egalitarian* wing constituting the similarity of both sexes, the *gynocentric, essentialist or differences* movement postulating the – mainly biologically founded – differences between men and women, and the *postmodernist* perspective which rejects essentialism and fixed definitions of gender attributes instead allowing for multiple views and realities. A fourth, recent movement is *postfeminism* challenging amongst others the current 'end-of-feminism' postulate.

The *egalitarian* advocates who stem mainly from the social sciences with Simone de Beauvoir as one of their most famous supporters argue that men and women have similar inherent preconditions and are only constructed 'masculine' or 'feminine' by education, society and role models, with political and economic interests supporting this distinction in favor of a clear gender-specific separation of work discriminating women. Men define women in relation to themselves as 'other', as relative, imperfect beings keeping them from transcending out of their assigned role framework and from obtaining an equal share of the political and social life. This notion lead Beauvoir to her famous statement that *"one is not born a women – one becomes one"* ([1951] 2009, 334). A basic conclusion of egali-

tarian feminists is that only a complete elimination of gender differences - including the feminine space - can lead to an equal treatment of men and women (Galster 2008, 47).

In contrast, the supporters of the *differences* theory - coming rather (but not only) from psychoanalysis - see major distinctions in the way men and women think, feel and act due to their specific physicalness and blame a patriarchal society to negatively judge female attributes in favor of an individualistic male culture glorifying death, violence and destruction. One of the key figures of this *gynocentric* movement which started to prevail in the discussions mid of the 1970s is Iris Marion Young, former supporter and follower of Simone de Beauvoir. From her new perspective, she criticizes the egalitarian denial of gender-specific behavior, skills and values for cementing the patriarchal norms and masculine values and argues for the positive rating of female attributes and qualities in society postulating them as a political instrument to enhance the status of women towards more gender fairness (see e.g. Lucke 2003; Jörke 2009).

Postmodern feminism is a theoretical framework with widely varying viewpoints which is strongly influenced by postmodern philosophy building on the ideas of philosophers like Nietzsche, Foucault, Derrida or Lacan (see e.g. Englert 2009; Wright 2000). It rejects traditional essentialist practices declaring that 'reality' is only a subjective impression being constructed by language and symbolism, often in a so-called *"performative"* way (Engelmann 2007, 140ff) and concludes that, as a consequence, the existing categories of gender and sex – including a general category 'women' – are devoid of meaning (von Hoff 2009, 188ff; see also Villa 2008a, 146, ff; Villa 2008b, 264f; Bartky 2005, 325f). In "*Gender Trouble*", poststructuralist philosopher Judith Butler whose work is closely related to postmodernism criticizes previous feminist movements stating that *"[…] the category 'women' […] is being brought forward and restrained exactly by those power structures that are meant to support the objective of emancipation"* (Butler 1991, 17). The supporters of postmodernism suggest methods like deconstruction, genealogy or narrative and discursive approaches to create a new version of the truth – or rather: multiple truths and realities based on the diversity of gender, the respective situations and viewpoints.

Specific modern feminist strands that look at the construction of technology, nature and the environment are e.g. technofeminism, cyberfeminism, or ecofeminism (see e.g. Thiessen 2008, 39).

A major stream of the *postfeminist discussion* deals with the question whether the claims of feminist equality achievements hold true. In "*The Aftermath of Feminism*" McRobbie argues against this 'end of feminism' postulate and points out how the traditional gender and power structures get re-established in the guise of the increasing emphasis on the consumer and popular culture, specifically in the beauty and media industry, concluding that *"feminism is instrumentalized" […] and the consent and participation of young women is sought, and seemingly secured, in a multiplicity of ways that defy the notion of a centralized power"* (McRobbie 2009, 5ff).

1.4.1.3 Chronological Waves

The development of feminism in Europe and North America is sometimes also described using the image of different waves (see e.g. West 2010). From this perspective, four major – partially overlapping – waves can be distinguished: *First-wave feminism* in the 19th century basically aimed at leveling the playing field with regard to equality in basic areas like property rights or voting rights. *Second-wave feminism* starting in the 1960s in general focused on cultural, social and political aspects of discrimination, like equality in employment, sexual harassment, and the political consequences of gender differences. *Third-wave feminism* in the 1990s, while building upon the topics of the earlier movements, addresses issues of feminism across class, race, sexual orientation and culture emphasizing female diversity. And finally, one could define a *fourth wave* in the late 20th and early 21st century encompassing postmodernism and postfeminism including the further development of feminist thought but also the claim of the "end of feminism" and various critiques of previous feminist theories (see e.g. Field 2000).

1.4.1.4 Criticism and Discussion

There is much scholarly and literary discussion and criticism around all those concepts. One for example deals with exclusion and class separation, e.g. between white middle-class and proletarian women, or between blacks and whites, and also with the assessment of heterosexuality versus all other forms of sexuality in different theories (Thiessen 2008, 40f). Another point of critique targets today's increasing 'feminization' of almost all sociological subjects which is said to partially already result in an oblivion of men, e.g. in the current discussion around the compatibility of family and work (Lucke 2003).

A specific 'bone of contention' of most theories is that while feminism strives to eliminate mechanisms of suppression and marginalization trying to broaden the perspective towards a more diverse picture appreciating female values and traits, its argumentations and emphasis on the biological merits of the female sex at the same time often unintentionally lead to a cementing of the criticized core dichotomy 'men – women'. Others condemn precisely the elimination of this dichotomy proposed e.g. by Butler and the postmodernists as being unnatural and counterproductive for human life (see. e.g. Lucke 2003, 21f; Thiessen 2008, 40 ff). I agree with Gerhard (2004) that the apparent feminist paradox of requesting equal rights while at the same time proclaiming the differentiation of women from men (also called *"Wollenstonecraft dilemma"*) as criticized for example by Luhmann (1988) shows in fact feminism's aptitude for reflection and self-observation, *"just as sociology itself behaves when diagnosing and interpreting crises in the development of modernity"* (Gerhard 2004, 131). As the diversity and controversies of the various feminist streams indeed tend to create a certain level of confusion, I like Campell's approach (2004, 196) to summarize all thoughts to be rooted in three basic beliefs from which all feminist groups work in *"distinct, but organically connected ways"* (ibid.) to accomplish benefit for all women:

> *"The right of each and every woman to full humanity*
> *A commitment to act for oneself and for all women*
> *The goal of social justice and systemic change."*

And, finally, I think Haraway (1988) adds an interesting and broader perspective with the following statement:

> *"Feminism loves another science: The sciences and politics of interpretation, translation, stuttering, and the partly understood. Feminism is about the sciences of the multiple subjects with (at least) double vision. Feminism is about crucial vision consequent upon a critical positioning in unhomogeneous gendered social space."*

In this thesis, I use the term 'feminism' analog to Sefyrin (2010) as an epistemological approach summarizing assumptions, theories and methodologies towards achieving gender equality and will point to specific streams whenever necessary.

1.4.2 **Gender**

The term ‘gender’ is closely linked with feminism. It is an anglo-saxon term which has been introduced in the 1970s as a means to differentiate between biological sex and the socially and culturally constructed masculinities and femininities – much like Simone de Beauvoir’s *“one is not born a women”* (see e.g. Meissner 2008; Lucke 2003; Krings 2002a; Oakley 1972). According to Van Oost (2003) the shaping of gender takes place at three different levels: On the *individual level* as expressed in skills, attitudes and identities, on the *structural level* by means of a gendered division of labor, and on a *symbolic level* with cultural processes, norms and values being associated with masculinity or femininity. What is perceived masculine or feminine varies over time and place showing that gender is a *“dynamic and multiple phenomenon”* (ibid.). A frequently quoted definition of how gender materializes within organizations and processes was coined by Acker (1990, 146):

> *“To say that an organization, or any other analytic unit, is gendered means that advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine. Gender is not an addition to ongoing processes, conceived as gender neutral. Rather, it is an integral part of those processes […].”*

1.4.2.1 Feminist Perspective: Many Truths

The idea of a socially constructed gender can be seen as a “*minimum consensus*” in most areas of feminist and gender research (Meissner 2008). The question of the breadth and depth of this construction yet sees some discussion and ranges from the insights that there are as many categories of women as there are different contexts, e.g. with regard to class, age, race, geography, sexuality, education etc. (ibid.) to a complete negotiation of the basic binary construction ‘men – woman’. The latter, most controversial theory deviating substantially from other branches of feminism is based on Judith Butler’s argumentation that the biological sex itself is constructed and a product of language and symbolism (Butler 1991, 22ff). Butler actually criticizes the still too narrow distinction between sex and gender stipulated by previous feminist schools of thought pointing to the fact that also material things like the body can be subject to social construction.

Relating to the way individuals create a socially constructed gender reality for themselves and others by means of language and symbols, West/Zimmermann (1987, 126) coined the concept of *"doing gender".* They understand gender (ibid.)

> *"[...] as a routine, methodical and recurring accomplishment [...] undertaken by women and men [...] involving a complex of socially guided perceptual, interactional, and micro-political activities that cast particular pursuits as expressions of masculine and feminine natures."*

Thus, gender and sex are not seen as the basis for differences in human behavior but vice versa – as the result of complex social processes (Gildemeister 2008, 137).

1.4.2.2 Political Approach: Gender = Sex?!

Krings (2002a, 5) describes the vivid and controversial discussions during the 4th UN World Conference on Women in Beijing around the concept of gender as a social construct by many national and spiritual delegations including the Vatican who feared a marginalization of the biological sex. As a result, the final report defines the term 'gender' as "*an alternative opportunity to refer to men and women*", 'gender equality' as "*a synonym for the equality of men and women*", and 'gender awareness' as "*being conscious with regard to the different implications of political decisions on men and women*" (ibid.). The so-called 'gender mainstreaming' is a strategy and concept to create gender equality in daily life. It mainly appeals to governments and institutions to consider the perspective of gender in all political decisions and programs (United Nations 1995; see also Zimmermann/Metz-Göckel 2007, 13ff; Meuser 2004, 101ff; McGregor/Bazo 2001, 18 ff).

1.4.2.3 Industrial Approach: Managing Diversity

In parallel to this political implementation of gender equality concepts that aim mainly at creating equal opportunities based on ethical considerations, industry has increasingly established the American idea of 'diversity management' recognizing that a pro-active valuation and inclusion of the variety of ethnicities, age, gender, religion etc. has a positive effect on the economic success of most companies (see e.g. Schraudner 2010, 13; Pasero 2004, 156).

1.4.2.4 Scientific Implementation: Gender Studies

The scientific discussion of gender has emerged from the area of women's studies in social sciences. While women's studies were characterized by a close relation of theoretical analyses with political aims to improve the position of women, gender studies deal with the cultural assessment of masculinities and femininities in the context of social organizations and also link into other sciences and topics like technology, physics, mathematics or medicine. (see e.g. Braun/Stephan 2009, 32; Leicht-Scholten 2007, 9ff; Zorn et al. 2007, 17; Krings 2002a, 5). Including both men and women, the scientific approach to gender implies a structural difference but at the same time strongly emphasizes the level of social and cultural diversity within and between the sexes thus building a joint platform and broad basis for various theories and approaches (Krings 2002a). Concepts and focus have shifted over time with changing interests as well as theoretical and political positions with regard to the gender gap. I will briefly introduce three perspectives that are close to some of the feminist theories described above and that have led to different kinds of measures and activities by policy makers and companies - the liberal tradition, standpoint theory and post-structuralism (see e.g. Maass et al. 2007, 12ff): In the *liberal tradition*, common amongst policy makers, men and women are seen as equal. Activities aim at helping women to overcome existing disadvantages and at unfolding discriminatory practices. The key point of the *standpoint theory* is that women and men are fundamentally different and that 'femininities' need to be revalued with systems and cultures having to adapt to the female requirements. The post-structuralist view takes a wider approach looking at how identities or 'gendered subjectivities' are shaped by language and images in order to deconstruct and redefine 'masculinity' and 'femininity'. Becoming more embedded into academia, the focus in gender studies has shifted – often combining other axes of diversity like race, age or ethnicities – towards *"analytical, deconstructive research questions, which are relevant for changing society"* (Zorn et al. 2007; see also chapter 3.1.4).

1.4.2.5 Criticism and Discussion

Scholars still partially struggle with the term 'gender' and the interpretations vary based on the respective theoretical positions and scientific perspectives (Zimmermann/Metz-Göckel 2007, 19f). According to Meissner (2008, 6ff), the negation of the binary relation of the sexes makes it "*a paradoxical category*". On the other side, a key point of criticism – very

much like for many feminist approaches – is that in practical use gender often gets reduced down to the biological dichotomy 'male – female' thus preserving the old categories, disregarding differences within the respective gender groups and unconsciously replicating the existing stereotypes and male norms (see also Maass et al. 2007, 13f; Frey et al. 2006).

Having pointed out the different concepts and views of the term 'gender' and being aware that many feminists, especially in the postmodernist tradition, might argue for a wider focus, this text – for the sake of simplicity – will be related to the basic categories 'men/ male' and 'women/female' recognizing that there are no stereotypes and each group is heterogeneous with regard to social and cultural criteria like e.g. education, age, social class or religion (see e.g. Bessing 2006, 19; Schraudner/Lukoschat 2006, 7; Wajcman 2000, 452; Fox-Keller 1995, 84f). I agree with Liz Popolo (2006) that preconceptions and over-simplification based on gender or orientation let us miss the whole facets of individual personalities and have included her little cartoon to visualize this thought (figure 2). As I am specifically concerned with women's relationship to technology I will focus on the aspect of technology and masculinity only insofar as it illuminates and influences this relationship, but I will not analyze relations of gender and technology with regard to their implications for men and masculinity (for this perspective see e.g. Light 2006).

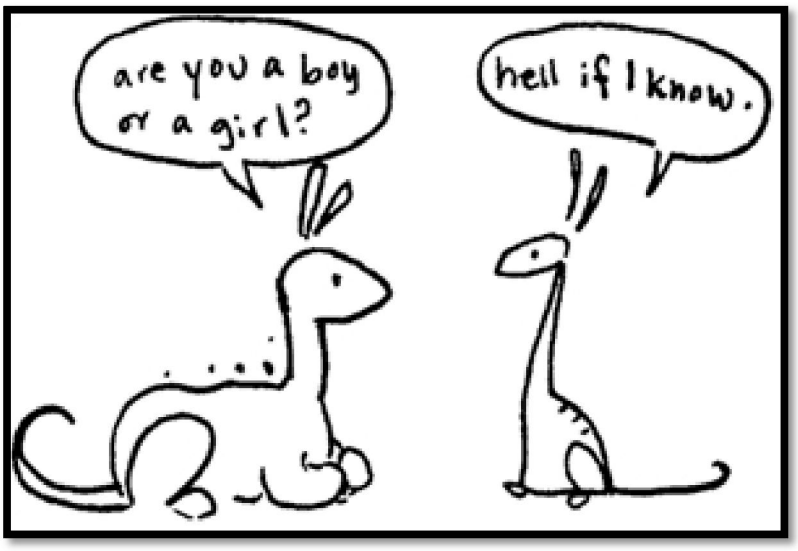


Figure 2: *Boy or Girl – Who Cares?*
Source: Liz Popolo (2006)

1.4.3 **Science & Technology**

Science and technology – and with them also the terms ‘research’, ‘engineering’ and ‘design’ – are often mentioned in the same breath, e.g. for purposes of reference, but also when it comes to the analysis of gender aspects in the context of one of the fields (see e.g. Smith Keller 1992, 5ff). As they indeed have multiple points of contact and overlaps, it is difficult to separate the areas. In particular, the feminist discussion often fails to make a clear distinction between science and technology as Wajcman points out (1991, 13). Staudenmaier (1985, 83ff) elaborates on the ongoing discussions and conflicting definitions of the terms in science and technology studies (STS) concluding that the boundaries between the disciplines have changed over time and with the different historical periods and perspectives.

Science and research are closely related and very often used interchangeably, e.g. when talking about ‘a scientific or research project’. In fact, this usage is not correct as I will point out below.

1.4.3.1 Science: Discovering and Explaining

The term ‘science’ has its origins in the Latin ‘scientia’ and stands for ‘knowledge’. Today, the definitions are more complex referring mostly to the incremental process of knowledge acquisition. Looking at the dictionary, science is amongst others defined as “*knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method*” (Merriam-Webster 2011). A major aim is to discover enduring principles of the phenomenal world. Natural sciences like mathematics or physics study natural phenomena, social sciences deal with human behavior, organizations and societies. Key paradigms in science are the so-called ‘scientific method’ and the empirical approach requiring the knowledge and results to be obtained by a distinct set of steps and to be based on observable phenomena that can be validated by other researchers in a similar setting (see e.g. Popper 1959). A distinction is also made between formal and applied science. While formal science deals with formal systems such as logic, computer science or systems theory and remains within a theoretical environment, applied science transfers scientific knowledge into the physical environment.

1.4.3.2 Research: The First Step to Knowledge Acquisition

Research in general refers to the actual gathering of information. This can be done in various different ways e.g. by observation, experiments, reading or search. In the scientific context, research is the first step in the process of systematic knowledge acquisition applying the scientific method. The OECD's *"Frascati Manual"* defines three forms of research (OECD 2002):

> *"Basic Research is experimental or theoretical work undertaken primarily to acquire new knowledge [...] without any particular applications or use in view.*
>
> *Applied Research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.*
>
> *Experimental Development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services or to improving substantially those already produced or installed."*

In a nutshell: Basic or fundamental research is driven mainly by the scientist's curiosity or interest without an immediate commercial objective whereas applied research leverages and uses theories, knowledge, methods and techniques to achieve a practical – often commercial – purpose. Applied research is often closely linked with experimental development and also called R&D, specifically in the industrial setting. Basic research is usually said to lay the foundation for applied research.

Empirical research based on the scientific method is divided into quantitative research generating statistics using large scale surveys and qualitative research exploring attitudes and behaviors by means of methods like interviews, notes, feedback forms or videos. In contrast to the large number of participants and rather short contact times in quantitative research, qualitative approaches seeking in-depth information about a person's ideas and experiences, target fewer people but the contacts tend to last longer. *Non-empirical research* is based on subjective interpretation rather than on evidence from the real world. Examples of non-empirical methods are scenario building, deconstruction, or Delphi techniques (see e.g. Clarke 2003; Smith Keller 1992, 5f).

1.4.3.3 Engineering & Technology: Designing Solutions

The relation and distinction between science and research being rather straight forward, science, engineering and technology are more closely intertwined terms and are subject to many debates – specifically with regard to the relation of engineering vis-à-vis the other two concepts. As engineering and technology are at the core of my set of research questions I will shed some more light on the various views and perspectives several authors take to explain the nature of these subjects. While in certain publications engineering and technology have been *"increasingly subsumed into science"* (Macilwain 2011), the author community of Wikipedia (2009) arrived at the following definition:

> *"Engineering is the discipline, art, skill and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge to design and build structures, machines, devices, systems, materials and processes that safely realize improvements to the lives of people."*

In summary, one can state that engineering is related to design and interdisciplinary theory and encompasses wider areas including processes and systems. It is often classified as a specific field of study and an applied science leveraging knowledge to create something structural, for example a solar power plant.

Technology, in contrast, relates rather to artifacts and applications that aim at controlling and adapting to our environments. Taking the example of the solar power plant as an engineering project, a key technological contribution was the development of the solar cell. Smith Keller defines technology as the usage of scientific as well as practical knowledge, tools and techniques to practical ends. Drawing a line to science she states that "*technology differs from science in that science is about discovering and explaining and [engineering and] technology [are] about designing and making*" (Smith Keller 1992, 25ff).

While technology is often based on the results from science and engineering, as a human activity it is much older than science, has a larger impact on daily life and in many places also exists without scientific input. The word comes from the Greek 'tekhne' (standing for 'art', or 'way of doing') and 'logike' (which means 'reasoning') – so technology can be translated "*reasoning about the art of doing*" (Smith Keller 1992, 24). Early on in their history, the human species already started converting natural resources into simple tools for hunting, shelter or for other purposes at the same time reasoning about the best materials and designs for these objects. So technology actually covers a wide range of meaning

starting with very simple artifacts and skills like using bone tools to cut animal skin and create clothing or the ability to control fire, to key inventions for mobility and communication like the wheel or the telephone, to extremely sophisticated devices like spaceships or the world famous particle accelerator - the 'Large Hadron Collider' - at the European Organization for Nuclear Research (see figure 3).

Figure 3: From Stone Age to High-Tech
- Bone Tools and the "Large Hadron Collider"
Sources: http://www.primitiveways.com/ and Google Images

An interesting approach that exemplifies the varying nature of the term 'technology' has been created by Long/Dowell (1989). The authors differentiate three models of technology: The craft model, the engineering model and the applied sciences model. The *craft model*, also called 'master-apprentice model', refers to the older and basic technologies like wood-working or potting and uses practical rules of thumb. The technology develops over time and with experience, it can rarely be generalized and is often transmitted orally or at most in form of sketches expecting that the reader or follower knows a lot about the methods used. The model relates to earlier times and technologies in many Third World countries. The *engineering model* came up in the late Middle Ages seeking to apply hypotheses and testing in order to develop the practice of technology. Due to this more systematic approach the knowledge can be generalized and has been put down in writing. This model characterizes engineering in the 19th century and many of today's established areas like mechanical or civil engineering. The *applied science model* refers to the 'high-tech' development of the 20th and 21st century. It uses scientific knowledge and methods

and applies them to the solution of technical problems in areas like material sciences or electronic engineering. This form of technology often aims at changing nature to meet a certain objective, e.g. transforming metal in new ways for new uses.

Another way of looking at the topic is from the state of sophistication: Smith Keller (1992, 25ff) differentiates between low, high, intermediate and alternative technologies. *Low technologies* are the very basic methods of food production, shelter-building or health-maintenance that address the basic needs. *High technology* equals our Western usage and image of technology as a concept referring to large systems, e.g. for the production of food, that meet much more than basic needs and for which the demand must be artificially stimulated to achieve the necessary economies of scale. *Intermediate technologies* attempt to deliver the right scale of technological solutions specifically to poorer and third world countries where high-tech artifacts are not appropriate This concept is closely aligned to *alternative technologies* trying to minimize the environmental impact of technology. A specific example are renewable energy sources like solar cells on the roofs of small rural cabins in Third World countries that provide the electric power for cooking and heating mitigating the risk of open fire in the room and the corresponding health problems as well as eliminating the necessity to gather firewood as a key daily task for women.

The UK Technology Education Centre (2011) coined yet another perspective distinguishing five different views of technology containing additional organizational and social aspects:

> *"1. Technology as objects: Tools, machines, instruments, weapons, appliances - the physical devices of technical performance*
> 2. *Technology as knowledge: The know-how behind technological innovation*
> 3. *Technology as activities: What people do - their skills, methods, procedures, routines*
> 4. *Technology as a process: Begins with a need and ends with a solution*
> 5. *Technology as a sociotechnical system: The manufacture and use of objects involving people and other objects in combination."*

Johnson (2006, 2) further highlights the social aspects by stating:

> *"Technology is much more than engineering. While technology often originates with engineers, many other actors and institutions are involved in determining which technologies succeed, how technologies are used, and what cultural meaning is associated with them. […] We encounter technology as we move physically and socially through our lives."*

Adding to these thoughts around the larger dimension of technology, the final perspective I would like to share here is the idea of Pacey (1983, 4ff) who introduces the concept of technology as a *"practice"* in order to show the breadth of the topic including cultural and organizational aspects. Figure 4 visualizes this approach and illustrates also how the term is sometimes used in a restricted sense and sometimes with a much broader meaning:

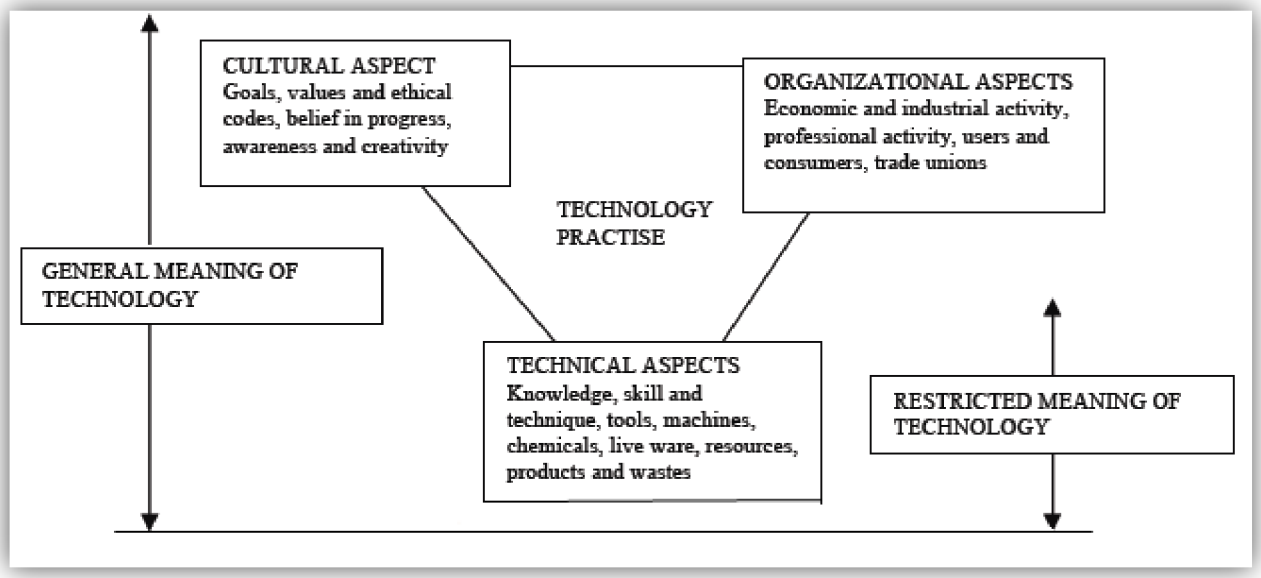


Figure 4: The Restricted and General Meaning of Technology
Source: Pacey (1983)

The nature of *design* as a key aspect of engineering and technology is similarly complex. Archer (1973, cited by the UK Technology Education Centre 2011) wrote that:

> *"Design is that area of human experience, skill and knowledge which is concerned with man's ability to mould his environment to suit his material and spiritual needs."*

In the context of engineering and technology, design is defined as a structured problem-solving process which begins with the perception of a need or the identification of a problem, continues with the formulation of a specification, the generation of ideas and a final solution, and ends with an evaluation of the solution (see also Bratteteig 2002).

Overall, engineering and technology have a huge impact on society and the life of each individual. It is through the use of these disciplines that we are able to leverage our natural resources to satisfy our basic and advanced needs. Both areas are indispensable for the development and growth of the infrastructure and the economic development of any nation.

1.4.3.4 Science and Technology Studies

Science and Technology Studies emerged in the mid-1980 when technology was added as a topic and notion to science studies programs. STS uncover and document how scientific research and technological innovation and design are affected by social, political and cultural aspects and vice versa (see. e.g. Johnson 2006, 3). In this context, gender has arisen as one of the major attributes of the so-called *"social shaping/social construction of technology"* (see e.g. Hackett et al. 2008; MacKenzie/Wajcman 1999; Hughes/ Bijker 1987). *"Feminist Technoscience"* (or feminist studies of science and technology) is an overlapping field of STS looking at ways in which gender is interweaved with natural, medical and technical sciences and within sociotechnical networks and practices. The term 'technoscience' was coined to emphasize the fact that science and technology cannot be separated from each other, or from society (Sefyrin 2010b) and that basic science – usually deemed neutral – is *"entangled in societal interests, and can be held as politically and ethically accountable as the technological practices and interventions to which it may give rise"* (Åsberg/Lykke 2010, 299; see also Weber 2006).

1.4.3.5 Criticism and Discussion

The field of Science and Technology is large, closely connected and interrelated – and in certain areas vividly debated. Some key points of discussion center around the established "Western" definition of the scientific approach as the *one* way to obtaining the truth by means of experiments, abstract theories and models devaluing all other scholarly disciplines (see e.g. Campbell 2004, 197). Smith Keller (1992, 5) remarks that

> *"All cultures try to make sense of the material world around them, predict cause and effect and develop techniques and knowledge to make artifacts, but many of the methods they use would not qualify as 'scientific' in our terms."*

Another area of debate is the question of whether and how science and technology and science and engineering are related and whether or not engineering and technology are "applied science". MacKenzie and Wajcman (1999, 6f) argue that while technology is often said to be applied science the two have "*by no means always been connected activities"*, and where they are linked they have contributed equally to each other (see also McCormick et al. 1993, vii). The UK Technology Education Centre (2011) states that

> *"Very little technology could be classified as applied science. Technology is marked by different purposes, different processes, a different relationship to established knowledge and a particular relationship to specific contexts of activity."*

Specifically, the notion of engineering as a synonym for applied science has triggered a lot of controversies, for example over the fact whether the 'linear model of innovation' stating that scientific discovery is the basis for engineering activity reflects reality. To invalidate this argument, many engineers – especially in the light of the public funding discussion that tends to privilege basic scientific research – often point to technological innovations like aviation or electric light that preceded the scientific understanding of the matter and nevertheless have added tremendous value for society (see e.g. Mcilwain 2011).

An interesting discussion is also happening around values and the negative and destructive side of technology. While many people still think technology is value-free and technological development proceeds independently of human purpose it can be clearly observed that this is not the case (see e.g. Riggs/Conway 1991). In the industrial culture materialist and prestigious objectives often dominate governmental decisions and sometimes even get out of control. Pacey (1983, 80) observes that

> *"[...] there are still occasions when technological development seems to escape political control, and when the imperatives behind it go beyond even military requirements as well as economic sense. The biased projections and one-sided world views of the experts sometimes have the effect of manoeuvring politicians into positions they never wished to take."*

A current example of this notion is the discussion around the runtime extension for nuclear power plants in Germany which is clearly dominated by the economic objectives of the operators arguing that 'German high-tech' is absolutely safe and putting pressure on the politicians to further support this dangerous technology. A historic example of an unholy alliance between the technological visions and excitement of engineers and the quest for political power is the development of the US nuclear program in the early 1950s. To point

out how the *"technological imperative"* can make certain scientists and engineers prioritize *"scientific curiosity and technological virtuosity"* higher than the welfare of mankind Pacey (1983, 124f) refers to Edward Teller, theoretical physicist and head of the 'Manhattan Project' who was charged with developing the first atomic bomb. All of his life, and even when after Hiroshima and Nagasaki the horrifying consequences of a nuclear explosion became clear to everybody, Teller was obsessed with the possibilities of this technology and a strong advocate of nuclear weapons without caring about the social consequences.

A specific point of criticism on the feminist writing in the context of science and technology is being set forth by Wajcman (1991) who argues that many feminist authors constructed science purely as 'knowledge' and transferred this view also onto their analysis of technology. Yet, as science includes practices and institutions so does technology which is basically about creating artifacts that shape realities and are being shaped by their creators. She thus stresses the need for a *"different theoretical approach to the analysis of the gender relations of technology"* (Wajcman 1991, 13) which will be part of my literature review on gender and technology in chapter three.

As my focus of interest is on the evaluation of gender aspects in the design of technology and specifically software solutions, I will primarily look at engineering and technology including applied research as well as experimental and actual development activities. I will use the term 'design' in a broader sense synonymously for the planning and creation of prototypes, applications and interfaces. In a narrower sense, I understand IT design as proposed by Suchman (2002, 100) as *"a process of inscribing knowledges and activities into new material forms".* The gender/women–science relations will not be explicitly analyzed. Yet, due to the interrelations and described overlaps between science, research, engineering and technology some argumentation along with the reasoning of various authors and scholars combines and partially mixes the terms and fields.

To sum up, figure 5 illustrates the general relationship between science and technology pointing out that while overlaps exists in an area that could be called 'applied science' there are a number of distinct differences between the two fields.

	Science & Research	Applied Science	Engineering & Technology
Key Goal	Pursuit of knowledge and understanding for its own sake (new knowledge) or towards a concrete aim (applied research)		The creation of artifacts and systems to meet people's needs (new products)
Goals achieved through	Corresponding scientific process		Key technological process
Development Methods	Discovery (controlled mainly by experimentation)		Design, invention, development, production
Evaluation Methods	Analysis, generalization and creation of theories		Analysis and synthesis of design
Quality achieved through	Drawing correct conclusions based on good theories and accurate data		Taking good decisions based on incomplete data and approximate models
Skills needed to excel	Experimental and logical skills		Design, construction, testing, planning, quality assurance, problem solving, decision making, interpersonal and communication skills
Mission	The search for and theorizing about cause and effect		The search for and theorizing about new processes
Motto	Reductionism, involving the isolation and definition of distinct concepts		Holism, involving the integration of many competing demands, theories, data and ideas
Value Judgments	Making virtually value-free statements		Activities always value-laden

Figure 5: Science versus Technology
Source: Further adapted from Sparkes (1992)

2. The Relevance of Gender for Technology Design

"Women are the biggest economic revolution of our time."

Avivah Wittenberg-Cox

In the 2007 Report *"Science, Technology & Gender"* the UNESCO assesses that despite the fact that women in some areas do significantly contribute to technological developments and also could benefit largely from technology "*women's concerns and contributions are frequently disregarded in science and technology policy, research and development"* (UNESCO 2007, 45). Women remain in most cases dramatically underrepresented in the respective policy- and decision-making bodies at all levels. Not only could they provide very little input to the research agendas, science and technology research has also mainly neglected their situations, interest and concerns, both from a physiological and social perspective – thus the UNESCO (2007, 51) rightly states:

> *"The advantages offered by new products and technologies cannot be used to their fullest potential if they do not complement the existing skills and knowledge of their intended beneficiaries – men and women."*

It appears there are many limitations to women's likely impact as consumers and creators of technology due to their remoteness from the decision and design processes. The gains can only be small-scale improvements as the choice is always constrained by the technologies currently in use. The general underlying problem to this situation has been dubbed 'Collingridge Dilemma' referring to the fact that consequences of new technologies are not always predictable, and by the time it turns out that something is wrong with a technology, both its artifacts and the social interest surrounding them, have become so entrenched that they represent major barriers to change (Collingridge/Reeve 1986; see also Faulkner 2001). Considering the fact that women represent half of every nations' human resource base, it is important to incorporate a gender-aware perspective with regard to technology policies and processes, and to integrate women much more closely into the process of designing technology as well as into the context of use.

2.1 Women - A Neglected Target Group

Markets have been changing heavily over the last decades due to the impacts of globalization, but also based on social and demographical factors. This includes the change in the gender ratio that has happened in the Western industrialized nations. While the gender of users has been a design variable in certain industries, like e.g. cosmetics, media or apparel for long, it has so far been largely neglected in the area of technology products – despite an increasing number of highly educated and economically independent women acting as autonomous customers and design-conscious users of technology (see e.g. Van Oost 2003). The development still mainly happens based on the underlying experience of a homogeneous group of scientists and engineers rarely considering the needs of female users in technological research, design and development (see e.g. Joost et al. 2010; Schraudner/Lukoschat 2006). In contrast, as touched on in the introduction, gender differences are rather being blocked out in the development of technology as illustrated by means of the speech recognition example (Schraudner/Lukoschat 2006, 3) and – much worse – the airbag system example where the negligence of the specifics of the female body might cause deadly injuries to smaller women and children (Rosser 2006, 15; see also Püchner 2009; Karpf 1987, 159).

A reason for this inattentiveness to obvious realities is seen in the continuous male domination in the areas of technology research, design and development. The respective departments are still staffed mainly with men, so gender stereotypes are being reproduced often without a deliberate consideration of alternative approaches (Joost et al. 2010; see also chapter three). This gendered design process can be illustrated using as a further example the development of the ‘smart home’, the technology-assisted house of the future as described by Berg (1999, 301ff). The designers unconsciously modeled the technology based on male norms giving priority to energy saving, safety, communication technology and entertainment mapping the habitation patterns of men who in general more often use the house for eating, sleeping and relaxing. The general habitation patters of women who are on average spending more time working at home, taking care of the children and of social activities for the family are not mapped. Honeywell even uses the slogan *“The house that will do the job for you”* (Berg 1999, 306) referring to the fact that all appliances are integrated into a single electronic network to increase comfort of use. ‘Job’ here does not refer to any actual work that is normally carried out in the house and com-

pletely ignores feminine connotated tasks. What is especially striking in this example is that women possess important skills and knowledge about life and work at home and would thus be a key resource for the design process and the ideal marketing target for the 'smart home'. Yet, the designers entirely neglected this highly relevant social group. Being asked for their target purchaser, both Honeywell and other manufacturers after several rounds of discussion finally admitted to see the user as *"the owner and synonymous with the man of the house […] who would share their fascination with electronic or technological gadgets"* (Berg 1999, 311; see also Pacey 1983, 104ff). Figure 6 taken from a Honeywell brochure perfectly visualizes this notion.

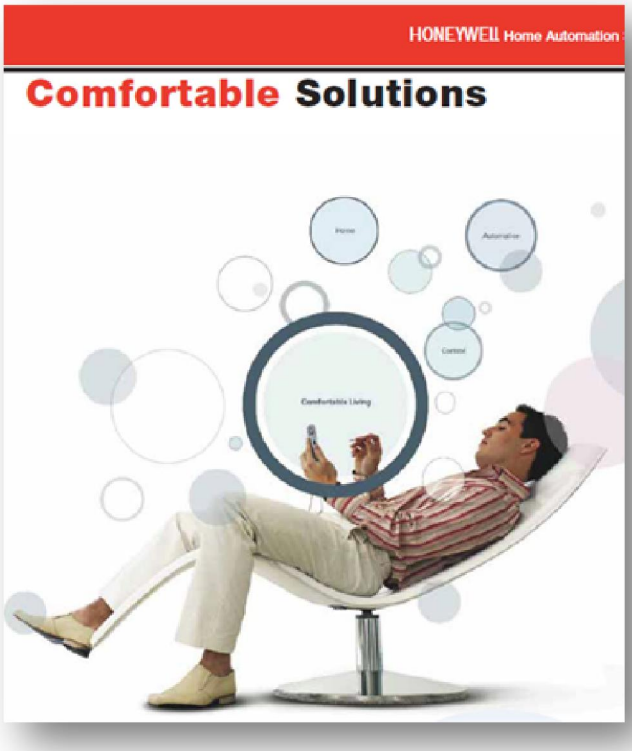


Figure 6: Home Automation – A One-Dimensional Perspective
Source: http://www.ae.com.tr/upload/HoneywellHomeAutomation.pdf

A specific phenomenon are companies that actually know their market is female but still develop products and do marketing for stereotype kinds of users marginalizing the reality and needs of its consumers. Wittenberg-Cox/Maitland (2009) report amongst other examples of a large American white goods company manufacturing washing machines, dish-

washers, microwaves and the like for mostly female end users. The firm is run almost exclusively by men, and the R&D director enthusiastically claims to *"contribute to the liberation of women"* while the management's ideas of what contemporary women might need appear to the authors to be *"locked in a historical deep-freezer"* (Wittenberg-Cox/Maitland 2009, 99f). He was utterly surprised when asked whether he could not better contribute to women's liberation by changing the notion in his marketing campaigns towards more job-sharing in housework – a demonstration of his unawareness of the situation of modern women and couples. All of these examples demonstrate that the marginalization of women in the context of technology has a profound influence on the design, technical content, use and usability of artifacts.

2.2 Social and Economic Benefits of Gender Awareness

In the following paragraphs I will point out that an increasing awareness of the importance of gender in technology design, a shift in mindset towards more equality and a focus on women as creators and users of technology will be beneficial not only from a social and ethical but specifically also from an economic perspective.

2.2.1 **A Question of Fairness and Equality**

The gender dimension of science and technology has become *"an increasingly important and topical issue worldwide"* (UNESCO 2007, 11; see also WSIS 2003). Realizing an ascent with regard to the percentage of women being creators and designers of technology directly contributes to more fairness between the genders and to the equality objectives set out by national and international policy makers. Since the 1976-1985 'United Nations Decade for Women' particular attention has been paid to the role of women in science and technology which was pushed further when in 2000 gender equality became one of the eight 'United Nations Millennium Development Goals'. The UNESCO defines its role in this context as "*taking up the issues and working to overcome gender disparities in access to, influence over, and use of science and technology*" (UNESCO 2007, 11). Adding to that, the UN implemented a dedicated *"Gender Equality Strategy"* aiming at addressing *"the array of gender gaps, unequal policies and discrimination that historically have disadvantaged women"* (UNDP 2008, 2). In Europe, gender mainstreaming was already official-

ly put into place for public institutions and EU-financed programs at the end of the 1990s, and implemented in the 6th Framework Program (European Commission 2008a):

> *"The Sixth Framework Program strives to promote gender equality in scientific research, through promoting the participation of women scientists and integrating the gender dimension in research content, wherever relevant."*

The fact that women make up more than half of all university graduates in the Western world - often outperforming their male peers - while their skills are not used properly is seen as *"a waste of women's talents and human resources"* (European Commission 2008a, 3; see also World Economic Forum 2010).

The EU 'Roadmap for Equality' goes a step further and adds a new economical and qualitative perspective leaving the level of pure equality as the political goal. A key objective is to have 25% women in leading positions based on the argument that the participation of women in science and technology needs to be promoted as it *"can contribute to increasing innovation, quality and competitiveness of scientific and industrial research"* (European Commission 2008b, 5).

2.2.2 **Financial Perspectives**

Innovative firms have proven to be more profitable than non-innovative firms (see e.g. von Hippel 1988, 5). Thus, the ability to continuously establish innovative products in the marketplace is essential for almost all companies to survive in today's highly competitive and globalized environment. The most important success criterion for each offering being the adoption by customers and users, it is key for the providers of goods and services to consider the needs of their major user groups early on in the design and development process. A study from the German Fraunhofer Society showed that around 40% of the overall development effort for an innovative product is induced by avoidable changes based on missing customer and market orientation (Bullinger 1990). The later in the process these changes need to be triggered the more expensive the overall innovation becomes and the smaller the profits will be. Companies who look at different user profiles and contexts of usage - including gender differences, aesthetic preferences and physical disparities - will have a competitive advantage (Schraudner/Lukoschat 2006, 9f).

2.2.2.1 Women as Innovators and New Sources of Revenue

An important aspect is also the pivotal role users play as sources of innovation in this process – compared to the longtime prevailing assumption that product innovations are typically brought forward by product manufacturers (see e.g. Oudshoorn/Pinch 2008; von Hippel 1988). Here as well, it would be financially worthwhile for the producers of technology to take a closer look at the inventive power of women (see e.g. the 'smart home' example in chapter 2.1) and other specific user groups like young parents, e.g. in the area of childcare or juvenile products. The 'baby jogger' (figure 7), a three-wheeled running stroller, is one of these famous examples of successful products invented directly by users – in this case parents who were active in sports (see von Hippel 2009, 38).

Schwartz Cowan as one of the first scholars pointed to the fact that technologies in the context of 'female issues' like child rearing, women's health, or basic household tasks are often not even classified as technology and left out of the considerations of historians and designers. Some of the many examples are tampons, baby bottles, bottle sterilizers, cradles, or the teeth ring (Schwartz Cowan 1979, 51ff). These 'mundane' technologies and the contributions women could bring to the design process are thus a huge untapped field to explore in order to develop new products and grow market share.

Figure 7: Baby Jogger – Original User Invention and Commercial Product
Source: von Hippel (2009)

Schraudner/Lukoschat (2006) provide arguments for the advantages of embedding gender aspects firmly already into the strategic R&D planning and for increasing the amount of female researchers, developers and designers: First of all, the integration of gender already at the stage of definition of the respective research area augments the wealth of related research questions and thus the innovation potential as beaten paths are being left and the chances for additional findings open up. Secondly, companies and institutions will get new starting points for the development of technologies, products and services by defining new contexts of usage, by enhancing existing offerings with gender-relevant features, and by creating additional solutions based on the defined new needs. Specifically for smaller firms, gender-sensitive design could be a good opportunity to establish market shares in a niche market (see also Rommes/Faulkner 2003). And thirdly, the integration of female views, expectations and preferences early on in the innovation process is very likely to make women as customers feel more attracted to the respective products, and thus the current distance to many technological innovations will diminish.

2.2.2.2 Purchasing Power and Gender-Aware Marketing

Several studies point to the increasing market and purchasing power of women urging manufacturers, suppliers and service providers to expand their view to include women as important stakeholders, users and consumers. McKinsey in their frequently cited study *"Women Matter"* (2007, 10) state

> *"Even in industries where buyers are traditionally male, women represent a growing proportion of the consumer base: For example, women influence 60% of new car purchases in Japan and make up about 47% of PC users in Europe. [...] Women are the driving force behind more than 70% of purchasing decisions."*

Reinforcing these findings, Silverstein and Sayre (2009, 2) ask:

> "*As a market, women represent a bigger opportunity than China and India combined. So why are companies doing such a poor job of serving them?"*

Analyses in the context of marketing and diffusion processes conclude that market research – by including gender relevant aspects – can also contribute substantially to a better understanding of the consumers and to a product design that has been adapted to the needs of the users. It turned out that especially women tend to react much more positively if the marketing approach focuses on the actual value of new technologies (see Neuss/ Drüner 2006). A study analyzed the interest in future technical innovations using the ex-

ample of ‘intelligent packaging’ – an innovation in the food sector containing a microchip that stores data along the whole production and logistics chain which can be comfortably retrieved and read via the Internet. The apparent value, a dramatically increased level of food safety, proved to be highly relevant for 60% of the women interviewed. This becomes manifest in a concrete willingness to pay a premium and specifically also in the readiness of 33% of women who declared themselves in general as ‘late majority’ or even ‘laggard’ with regard to new technologies to act as ‘innovators’ for this special product (Neuss/Drüner 2006, 102f; see also figure 8). This example is a strong case for the opportunities of a gender-aware marketing approach. The common notion of a female lack of interest in technological innovation could be based on the fact that companies normally do not try to create this direct link between their products and an actual value for different target groups. A strong focus on the real needs of – specifically female – stakeholders could turn much more women into early adopters of technology and thus grow the results for the industry.

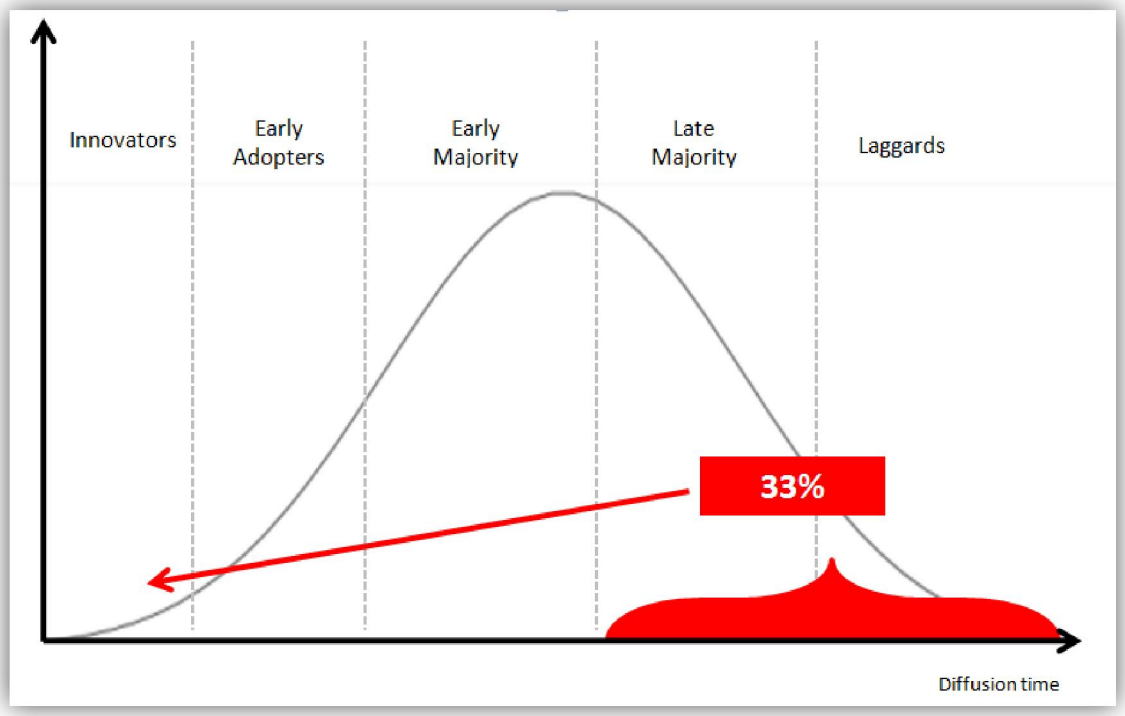


Figure 8: *33% of Female ‘Late Majority’ Could Become ‘Innovators’*
Source: Neuss/Drüner (2006)

2.2.2.3 Increased Organizational Performance

In addition to the increased financial performance opportunities based on a gender focus with regard to women as creators, co-innovators, users and consumers as described in the last chapter, McKinsey (2007) also argue that companies with a higher percentage of women in leading positions have overall a better organizational performance, more satisfied customers and on average better results than their peers (see also McKinsey 2008, Bierach/Thorborg 2006, 223). Priddat (2004, 166f) stresses that from an economic perspective no company in the knowledge society can afford not to tap the potential of all qualified women available for the benefit of its overall organizational success. Other research shows the potential that gender balance has on the innovation capability of professional organizations. Equal gender representation turned out to help unlock the innovative potential of teams. A 50/50 women/men composition proved to be the most innovative, while the all-male teams where the least innovative (Lehman Brothers Centre for Women in Business/London Business School 2007). Another special aspect highlighted is the positive correlation between female empowerment and sustainability progress, e.g. by an increased focus on renewable and environmental technologies (PriceWaterhouseCoopers 2008).

In summary, given the changing market conditions and the increasing role of women as autonomous and sophisticated consumers and users of technology, and considering the social, economic and ecological trends of our time, like global warming, the need for renewable energy sources, an aging population in Europe, or a growing demand for public safety and security, it becomes clear that new approaches to technology development which consider gender as an important factor and integrate women more closely are of paramount importance. The systematic integration of gender aspects in the design of technology is an important driver for the quality, usability and acceptance of new products and solutions and thus for the success of technological innovations in the market. In the future, companies can no longer afford to ignore this fact, thus Wittenberg-Cox/Maitland (2009, 5) rightly state:

> *"Gender is a business issue, not a women's issue."*

3. The Gendered Nature of Technology

"Technology is a medium of power."

Cynthia Cockburn

Having elaborated on the social and economic significance of gender awareness in technology research and design, I will now take a closer look at the question on why technology, and specifically IT, can be referred to as gendered. The masculine notion of science and technology is being seen as the major reason for the exclusion of women as designers and producers and their negligence as users of technology by most feminist scholars. In the following section, I will explore the indicators that lead many authors to this diagnosis and address the issues that result for the design and usability of technology.

3.1 Feminist Lenses

Interest in gender and science and technology has mainly arisen from the field of women/ gender studies, science and technology studies, and feminist studies of science and technology (see also chapter 1.4.3.4). So far, in many non-feminist publications, but also in the general linguistic usage and in research projects, the 'masculine norm' is still implicitly taken as a given. The scientific and economic truth is based on men, with women being classified as the ones different from the norm. Gender is seen as a variable, and not used as a lens. Scholars in the above fields have tried to create that lens and uncover in which ways and by whom science and technology are shaped and which role gender plays in this context. While the feminist discussions have always taken diverse and overlapping forms one shared concern between earlier and more recent theories is *"to interrogate the gender-power relations of the material world"* (Wajcman 2009, 143) to illuminate the many different ways by which the masculine notion of technology has – often negatively – impacted upon women. Based on these concerns and with regard to the absence of women in historical accounts of technology, feminist scholars have also played a leading role in drawing attention away from the engineers refocusing it more towards the users and uses of technology (Oudshoorn/Pinch 2008, 545).

3.1.1 **Science and Technology – Social Phenomena**

Until the 1980s, questions about the specific relation of gender and technology did not receive a lot of scholarly attention. The focus was rather on the science-gender relationship and the exclusion of women from scientific institutions (see e.g. Fox-Keller 1995, 85f). One of the first groundbreaking publications that debates the role gender plays in the scientific enterprise is Sandra Harding's *"The Science Question in Feminism"* (1986). Harding identifies the paradoxes and contradictions in feminist epistemological programs and critiques of science and argues for a replacement of the mystical notion of 'scientific genius and rationality' with a more adequate concept of *"science as a system of social relations"* including the interconnection of gender in these relations (Harding 1986, 58ff). While these theories about gender and science are an important input for the understanding of gender and technology they are not fully sufficient to address the specific character of technology (see also Pinch/Bijker 1987, 17ff). In the context of gender and science research mainly seeks to understand and explain the absence of women in science and the question of whether this lack of female scientists has an effect on the knowledge produced. Today, a parallel field of study in the technical area is engineering, and a parallel set of questions is being asked about the lack of women in engineering and the effects on the production of knowledge (see Johnson 2006, 1ff; Fox 2006, 47ff). Understanding the values, culture and practices of engineering and its focus on 'doing' - in contrast to the scientific quest for 'knowing' – is one important aspect for the analysis of gender and technology. Yet, as described in chapter 1.4.3.3 technology is more than engineering – it involves different actors and institutions that determine the ways of usage and the cultural meaning of the artifacts – as Johnson (2006, 2) emphasizes:

> *"Technology is […] a system comprised of artifacts, social practices, and systems of knowledge. […] Artifacts are inseparable from the social meanings and practices associated with them. […] Understanding gender and technology can be a matter of understanding how gender comes to be embedded and carried in the design and meaning of technological artifacts as well as in the use of such artifacts."*

This definition also underlines why feminist scholars in principle reject the idea of 'technological determinism', a theory of cause-and-effect claiming that technologies develop in predetermined directions as the result of an internal dynamic changing either because of scientific advantage or following an inherent logic, and that they determine social change.

Rather, the development of technologies is seen as an active social process (see Mac-Kenzie/Wajcman 1999, 3ff; Rothschild 1983, xxiv). As Winner (1999, 29) taunts:

> *"Those who have not recognized the ways in which technologies are shaped by social and economic forces have not gotten very far."*

A classic work in the field of this social shaping of technology and artifacts is the analysis of the evolution of the bicycle design. Bijker (1997, 19ff; see also Pinch/Bijker 1987, 28ff) delineates that the development of the bicycle did not follow a linear path and that the 'dominant design' that finally emerged is the result of multiple interest groups, e.g. young men, elderly men, women, sports bikers and tourists, getting attached to it for different reasons and design preferences like social status, dress problems, security considerations etc. One model in the evolution of the design, the high-wheeled 'Ordinary' was considered unsafe, specifically by elderly men and women, yet, exactly this risky nature and the aspect of danger were interesting for another group, "*aristocratic young men [who] drove high-wheeled bicycles in Hyde Park to show off for their lady friends"* (Bijker 1997, 19). So, for a certain time this version dominated the scene before finally after more than a decade of evolution the low-wheeled 'Safety Bike' that allowed road transportation and let families tour the countryside resulted as the enduring design (see figure 9).

Figure 9: From the 'High-Risk' Bike to the Dominant 'Safety' Design
Source: Google Images

This example illustrates the influence of various technical, social and economic factors – of which gender is an important one – on the meaning associated with a technological artifact and ultimately on the success of a certain technological design over another. In addition, it shows that in the design process of a new technology there is *"considerable interpretative flexibility and contest about the meaning of the […] artifact and thus its eventual shape"* (Faulkner 2001, 85). The *"Social Construction of Technology"* approach developed by Bijker et al. (1987) describes this idea of users being active participants in technology development and challenges the theory of a structured, linear model of innovation in favor of a multidirectional model in which different social groups attach meaning to an artifact based on their individual interests and objectives. Or, as Suchman (2010, 101) puts it two decades later:

> *"Technologies can be understood as materials whose stability relies upon the continuous reproduction of their meaning and usefulness in practice."*

3.1.2 **Technology and Masculinity**

In the broadest sense, masculinity *is "the way men behave […] think and feel about themselves"* (Murray 1993, 65). Far from being a natural or biological category, masculinity is today seen as a socially shaped, relational category which together with femininity forms a framework with *"multiple and ambiguous boundaries"* (ibid.) between the two concepts. Pointing to the fact that men constantly struggle to achieve and maintain a highly competitive level of masculinity Seidler (1989, 151) states that it is "*not something we as men can be relaxed and easy about. It is something we have to constantly prove and assert".*

Although women have in fact been historically engaged with technology, both as designers, producers, users and consumers, feminist scholars and representatives of other scientific fields argue that technology itself is a masculine construct (see e.g. Döge 2002). As a result, women were to a large extent invisible throughout the history of technology, as were their contributions (see e.g. Rothschild 1983, 3). Different feminist approaches have tried to analyze and explain the social structures of power, patriarchy and capitalism leading to the phenomenon of technology being *"one of the last bastions of male domination"* (Fox et al. 2006, 2; for an overview of the most prominent publications in this context see also e.g. Wajcman 2009, 143ff; Brayton 2006, 759ff; Faulkner 2001, 79ff).

Efforts to theorize the gender-technology relationship cover various perspectives (see also chapter 3.1.4). Attempts to explain the male domination in technology are for example that technology demands some essential masculine traits, or that technology is designed by and for men to oppress women, or simply that it exists *"because technology is where the power is"* (Faulkner 2001, 84; see also Linn 1987, 132). Ecofeminists have argued with the missing relationship between men and the environment leading to an emotional detachment from the natural world and a focus towards technology (see e.g. Cox 1992). Other streams are based on psychological traits stating that e.g. computation technology as an embodiment of the abstract and formal – a *"rule-driven system that can be mastered top-down in a divide-and-conquer way"* (Turkle/Papert 1990, 135ff) – appeals more to men than to women. Over time, with the advent of gender becoming a topic also in STS in the mid-1980s, the feminist analyses of technology shifted from the question of women's access to technology to the processes by which technology is developed and used, and gender is constituted. Cockburn (1985) and Wajcman (1991) were amongst the first scholars discussing the social and mutual shaping of gender and technology looking at how the production and use of technology are shaped predominantly by male power and interests (see also Wajcman 2004; MacKenzie/Wajcman 1999; Bijker 1997; Kirkup/Keller 1992; Bijker et al. 1987). Today, the so-called 'co-creation' thesis – the idea that gender and technology co-evolve – is widely accepted. Gender patterns in society are said to be reproduced in technology, and if gender has been coded into a technology, that technology may reinforce gender patterns in return – as Johnson (2006, 3) puts it: *"Gender affects technology, and technology affects gender".* In a recent publication, Wajcman (2009, 149f) again stresses that co-creation also means that *"things could be otherwise"* – technologies are not the inevitable result of the application of scientific and technological knowledge but emanate from sociotechnical processes with gender being an integral aspect. Thus, it is import that women are involved in the processes and practices of technological innovation as their marginalization in the technological community has a *"profound influence on the design, technical content and use of artifacts"* (ibid).

Based on these ideas, in the next paragraphs I will analyze and describe some of the sources and manifestations of gendering in technology and the issues that arose and still exist for women. At this point, I would like to stress again that the usage of the dualism male/female and generalizations when talking about men and women are a means to explain the broader context of male dominance in technology. Of course, the described

behaviors and characteristics do not generally hold true for all men or women, or gender, who constitute various heterogeneous groups that need to be differentiated and looked at from different perspectives for different questions and research approaches (see. e.g. Krings 2002b, 10).

3.1.2.1 History, Culture, and the Sexual Division of Labor

Wajcman (1991) and Cockburn (1992) point out how modern technology and hegemonic masculinity are historically rooted in the Industrial Revolution which was the starting point of industrial capitalism fueling the sexual division of labor and giving rise to specific gender roles and values locating women in the private home sphere with children, and men in the public work sphere dealing with technology. Cockburn illustrates how women – although major contributors to the production process since the beginning of time – in the course of the centuries were more and more excluded from skilled labor and exploited by employers while being denied the opportunity to unionize for better working conditions. Men, in an effort to preserve their jobs and ranks often supported these mechanisms and *"consciously and actively [...] hedged women into unskilled and low paid occupations"* (Cockburn 1992, 208; see also Rothschild 1983, 4). A famous example of this relationship between skilled work, technology and masculinity, and the mutual formation of class and gender is the history of typesetting technology in Britain described by Cockburn (1983, 61ff): End of the 19th century, the industry began to mechanize typesetting by introducing the Linotype technology. To save labor cost, the employers tried to break the craft strength of the male compositors' union by means of splitting the tasks of keyboarding and casting into different machines. The shift to the 'QWERTY' keyboard used in typewriting – which had already become a feminized type of work by then – was supposed to get lower paid women to enter the typing part of the jobs. Yet, as the linotype machine (see figure 10, left) was set up to do both and had a completely different keyboard, the compositors' union fought for its technological development blocking the diffusion of the typewriter keyboard. In securing their sole use of this new technology, they effectively hindered women from entering these higher skilled, better paid areas of work. For the compositors the move from linotype to computer typesetting that followed years later – and finally led to the introduction of the 'feminine' QWERTY keyboard – was seen as an affront to their craftsmanship, and they fought massively against it. Both the (masculine) employers and the male typesetters demonstrated an interest in *"creating and sustaining occupational*

sex segregation" (Wajcman 2004, 27). The example shows how important the masculine monopoly of technology has been to defend the notion of skilled work as men's work. Machine-related skills and physical strength have been symbols of masculinity until today.

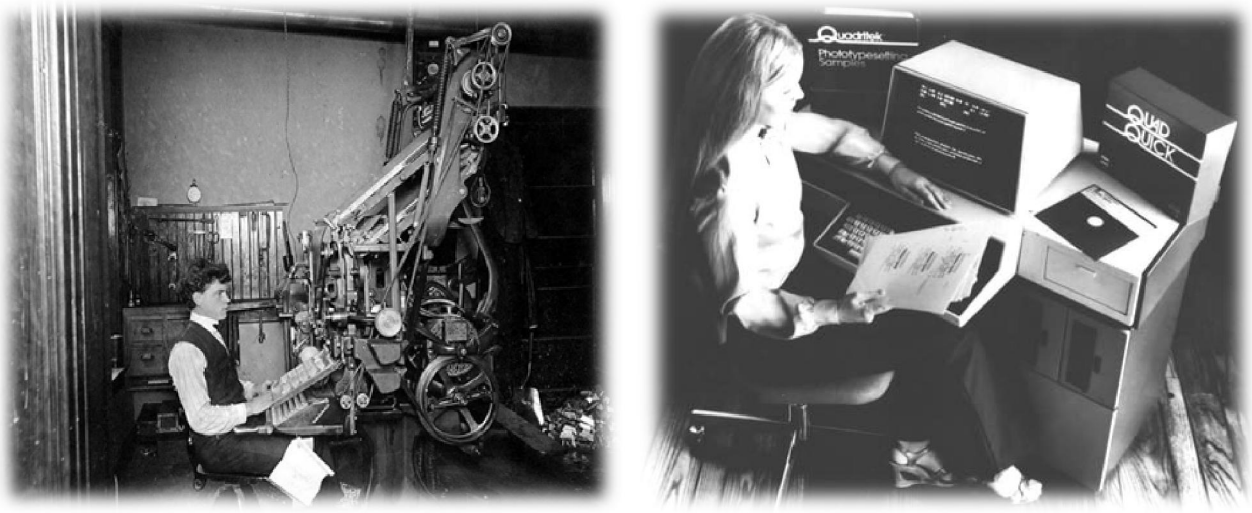


Figure 10: The Evolution of Typesetting – Linotype Machine and Computer Setting
Source: Google Images

And even though over time technical change has led to most jobs becoming less difficult, lighter and cleaner – more like the traditional characterization of 'women's jobs' – the distinction between men's and women's work has often been reconstructed along a 'technical/non-technical division line' (see e.g. Game/Pringle 1984, 17ff). Thus, even in the new era with an increased proportion of women entering the different industries, men occupied the best-paid and most interesting jobs with good career opportunities while women mainly did the low-level routine jobs. Examples are banking, clothing manufacture, mail order, or the domestic appliances industry. In this context, Game/Pringle (ibid.) firmly reject that technology is neutral arguing that it is the result of *"social processes […] designed in the interest of particular social groups, and against the interests of others*". Cockburn in analyzing the situation of women in the modern industrial setting (1985, 142) sadly states:

> *"The significance of the role we've found women playing in all the new technologies is simple: They are operators. They press the buttons or the keys. They are the ones who do with the machine what it is made for: they produce on it – CT scans, graded patterns and lays, or simply completed orders for the mail order packers to parcel up. Their role is output not input. What women cannot be seen doing […] is managing technology, developing its use […] Women are acquiring the 'what' kind of knowledge, but not the 'how', the 'why' and the 'whether' of technology."*

In this way *"occupational segregation is established as a crucial factor in the creation of gender identity and of power relations based on gender"* (Liff 1987, 177 – in an essay reviewing Game/Pringle 1984). Rosser (2006, 17) describes capitalism and patriarchy as *"mutually reinforcing parts"* of a system where the sexual division of labor together with wage labor form a central feature of capitalism, and where gender differences in wages along with the disesteem for women's contributions to reproduction and child rearing – which in the capitalist economy do not count as productive work – reinforce patriarchy and power differentials in the domestic sphere.

Wajcman (1991) argues that already the basic definition of technology was shaped by these patriarchal and capitalist relations that assigned value only to the productive technologies used and produced in the male workplace – women's use and production of technologies in the domestic, reproductive and leisure area has been mainly overlooked and ignored. This misconception between the heroic, male 'technoscience' on the one hand and mundane, female 'appliances' which are not even categorized as technology on the other hand is highlighted by many authors (see e.g. Brayton 2006, 760; Kirkup/Keller 1992, 29; Vendramin et al. 2001, 72; Pacey 1983, 104ff; Schwartz Cowan 1979). Pacey (1983, 104) aptly describes this phenomenon as follows:

> *"'Technology', like 'economics' is a term conventionally defined by men to indicate a range of activities in which they happen to be interested. […] Nearly all women's work, indeed, falls within the usual definition of technology. What excludes it from recognition is not only the simplicity of the equipment used, but the fact that it implies a different concept of what technology is about. Construction and the conquest of nature are not glorified, and there is little to notice in the way of technological virtuosity. Instead, technique is applied to natural processes of both growth and decay. […] Appreciation of process in this sense partly depends on accepting and working with nature rather than trying to conquer it, and is a neglected concept in conventional technology."*

Specifically engineering arose as a discipline with strong links into the military culture. A traditional view of technology tends to be the one of *"industrial machinery and military weapons"* which as important and masculine *"tools of work and war"* dominate and overlook technologies that affect most of our daily lives (Wajcman 2009, 144). Hacker (1989) elaborates how the military emerged as an institution from fraternal interest groups where men protected the community of women, children and the elderly. Weapons and guns became synonyms for power and manliness. The military labor was highly valued, whereas the community-oriented labor of women was neglected and often not even compensated. Engineering as a discipline got designed to train – mainly white, middle-class –

men for military roles. As the first military schools were engineering schools (e.g. 'West Point' in the United States), technology became associated with the military, dominance, power, and masculine values. In addition, the military initiated and supported *"technical competition, merit, and especially discipline and control that defined both masculinity and success"* (Hacker 1989, 66; see also Brayton 2006, 761; Fox 2006, 54). Rosser (2006, 18 – referring to MacKenzie/Wajcman 1999) points out how the understanding of class relations emerging under capitalism and gender relations under patriarchy helps to explain the close links between military and masculinity which are a key driver for many technological innovations in Western countries, mainly in the United States. It also helps to understand how and why choices were made to develop technology in a certain way for certain influential and wealthy stakeholder groups, e.g. weapon systems, favoring them over 'less important' technologies that would yet aid many people, like e.g. care systems . Figure 11 is a satirical metaphor of this masculine 'combat culture'.

Figure 11: A Masculine Culture of Technology
Source: Wajcman (1991)

In the late 19th and in the beginning of the 20th century, this development finally led to the cementation of the narrow definition of technology making it an equivalent for 'machine(s)'. The term 'technology' had gained much significance in public debate - legitimizing the exclusion of women from this social domain. Oldenziel in portraying the situation (1999, 31) states: *"The machine […] became a national icon marked as male"* - (see also Döge 2002). Engineers had finally risen to an elite that claims exclusive rights to technical

expertise, *"tasked to establish the mastery over nature"* (Noble 1998, 291), and the male professional identity became inextricably connected with educational qualifications, managerial career aspirations, physical strength and individual achievement, while at the same time women were interpreted as being *"ill-suited to technological pursuits"* (Wajcman 1991, 146; see also Wächter 2002). Modern technology had thus become fully associated with men. In fact, again only with white, male engineers as Oldenziel (1999) points out: The prevalent understanding of technology does not only devalue female competences but also those of men from non-occidental cultures: *"Better machines and equations were being invoked to demonstrate that men of one type were superior to those of another"* (Adas 1990, 14). Döge (2002) stresses the fact that until today, political and scientific technology decision boards are mainly staffed with men – which he sees as a major reason for the predominance of a deterministic perspective and an affinity for high-risk, 'anything-goes' technologies. Technological progress is seen as an autonomous force closely linked to economic and social progress, while negative ecological and social effects are deemed the result of the *"incorrect application of technology"* (Döge 2002, 34). In this context, Krings (2002b, 14) cites the example of the 'care robot' that is enthusiastically marketed as a key to solving the problems of an aging society, yet, without considering the emotional needs of those people receiving such mechanical care (see figure 12*;* see also Crutzen 2010, 45).

Figure 12: Elderly Care Robot – Brave New World !?
Source: Google Images

3.1.2.2 Symbols, Dichotomies, and the Use of Language

Until today, symbols, images, the use of language, and systems of belief in the Western world closely link engineering and technology with men and masculinity and separate it from women and femininity – which is one of the reasons why women often do not even consider pursuing a scientific or technical career or are being discouraged by their environment (see e.g. Fox 2006, 54). As pointed out in the last chapter, modern technology and hegemonic masculinity are historically associated with industrial capitalism and linked symbolically by themes of control and domination. The 'mastery of nature' remains still today a powerful idea of science and technology (see Faulkner 2001, 81ff). A specific aspect of gendering can be found in the symbolism of technological artifacts, e.g. in the area of electro-mechanics, where certain parts are labeled 'male' and 'female' – thus also reinforcing the idea of masculine dominance and heterosexuality as the norm (Faulkner 2001). Murray (1993, 78) brings up an interesting thought and discussion on gender, symbolism and the masculine self-conception suggesting that

> *"[…] the male resistance to the 'dilution' by women and/or the feminine of science and technology as a culture and practice […] springs not just from a protection of power and privilege […] but also comes from a deeper motive to protect a masculine reality that has secured itself in the symbolic […] significance of science and technology. […] To 'take the toys from the boys' threatens those boys with the removal of one of the symbols that make them feel like boys and, significantly, not like girls. Without those toys […] the boys would no longer be boys as they and we know them."*

Furthermore, in the context of technology and masculinity a series of highly gendered dichotomies can be discerned of which I will only pick a small selection. Most of the examples are based on the general notion of Western philosophy to build conceptual binaries like e.g. culture versus nature, mind versus body, or reason versus emotion. In each case, the former is distinctively masculine and active and dominates the latter which seems to be systematically associated with the feminine (Braun/Stephan 2009, 1ff; see also Woodfield 2000, 21f). One of the technology related examples is the distinction between *people-focused* and *machine-focused* based on the sociological distinction between 'feminine expressiveness' and 'masculine instrumentalism'. Turkle (1988) describes for example how women often shy back from computing because of the apparently 'too technical' nature of the work and the standard image of the computer hacker or 'nerd' – so they write off the subject as too complicated, anti-social and home to characters who are not capable of establishing any meaningful human relationship. Another dichotomy is the

already described classification of technological artifacts into *hard technology* – large high-tech systems associated with masculinity and powerful institutions – and *soft technology* – smaller scale appliances of everyday-life – which are usually not even counted as technology, giving women the feeling of having no relation to 'real' technology. Since engineering is associated with scientific methods, this notion extends into the longstanding gender dualism of *objectivist rationality* associated with emotional detachment and abstract theoretical approaches to problem solving on the masculine side, and *subjective rationality* associated with emotional connectedness and concrete, holistic approaches to problem solving on the feminine side (Faulkner 2011, 89; Karpf 1987, 166). Hacker (1989, 41ff) describes how in engineering education the repetitive drills of mathematically based analytical problem solving methods are much higher valued than any other capability, and a system of artificial tension keeps even good students from graduating (ibid.):

> *"I asked one statics professor why we couldn't have two hours instead of one for the exam. His response […]: "If we gave the students more time, anyone could do it. The secretaries could even pass it".*

Unfortunately, such a system excludes much of the social context necessary for the design of new technologies (Faulkner 2011, 87). Again, this focus on strict scientific methods and 'real' technology in combination with the disrespect for alternative, more heterogeneous approaches often tends to alienate women and girls from the subject.

Benston (1992, 38f) explains how – besides the general masculine notion of many languages (see e.g. Saul 2010) – the various gender issues around technology have strong consequences for the verbal communication between men and women. She argues that while men create and validate most of the technical artifacts they also create the related meaning. Women who have been largely excluded from education and action in the context of technology do not have the same access, experience with concepts or with equipment as men do. Consequently, they have difficulties to express themselves in these standard terms and participate in a technology discussion on an equal level. This situation is worsened as men also tend to control the communication styles seeing themselves as authorities putting women in a non-expert role. One example of that notion are TV spots showing *"a male authority figure using pseudo-scientific terms to sell detergent […] to women"* (Benston 1992, 39). In defining their areas of expertise as *"the only legitimate areas of concern"*, women's whole realm is dismissed and the idea of their technical powerlessness is being constantly reinforced (ibid.).

3.1.2.3 Socialization, Education, and Professional Discrimination

Wajcman (1991, 153f) points to the importance of early socialization into gender roles. Amongst others, she blames the gendered nature of toys that encourage boys to be assertive, solve problems, experiment and regard specifically the technological aspects with confidence – skills which form the basis of mathematical, scientific and technological learning – while on the other hand 'girl's toys' like dolls completely lack that notion and foster skills which stress aspects like caring and social interaction (see also Huff 2002). Such gendered toys, and of course the family and environment supporting these mechanisms and acting as early role models, are a key element of the differentiated learning experience between girls and boys and also reflect the traditional and stereotyped division of labor between women and men.

Murphy (1994) refers to a study which was undertaken in UK schools proving that in design and technology classes – while the boys tend to immediately monopolize the technical equipments – girls show a much greater empathy with the users and consider crucial practical performance features already in the evaluation of products and systems (see also Webster 1996, 160ff). She points to the fact that it is exactly these heterogeneous approaches which are important for a successful and user-friendly design of technologies. In addition, studies on the acquisition of programming skills showed that female students tend to rather adopt an interactive 'bricolage' approach whereas male students favor a formal and hierarchical 'planning' approach. While both approaches work, teachers usually discourage the bricoleurs – as they do also negatively judge the different learning styles of the girls in the design classes – and recommend the formal methods, thus often keeping female students and girls from pursuing technology and computer studies any further (see Turkle/Papert 1990; Baran 1987). Figure 13 is a nice metaphor for the application of female technology skills combined with the hands-on development of user centric solutions in a 'mundane' area – and of a female designer who has been socialized to believe being incapable of dealing with 'real technology':

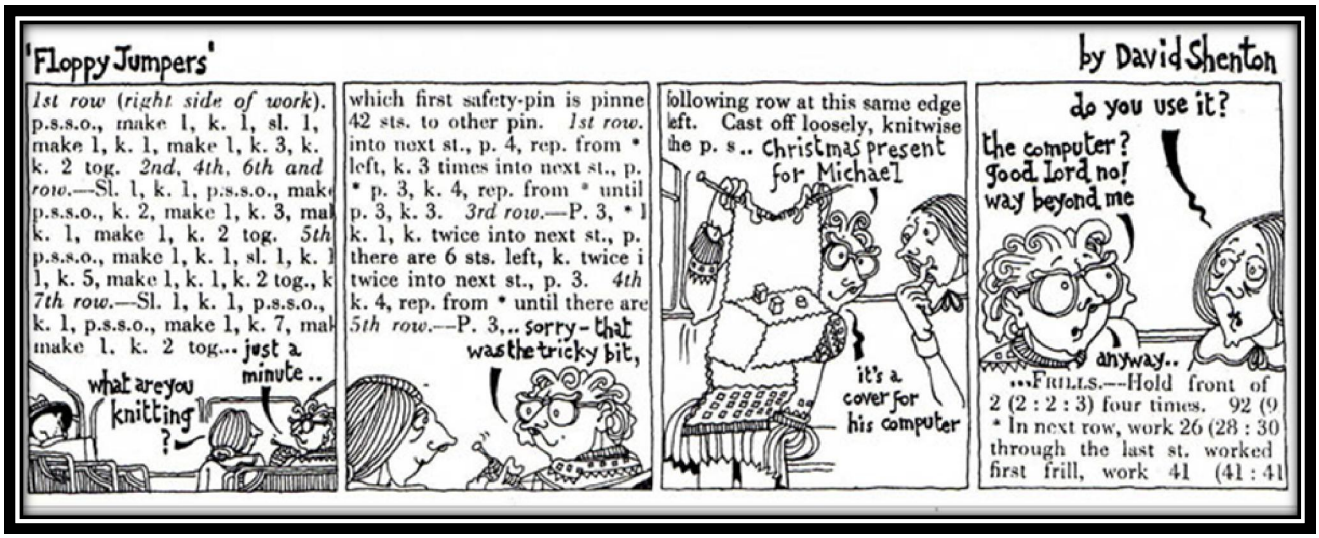


Figure 13: Underestimated Talents
Source: David Shanton (2008)

Dovzan (2011) confirms these findings and suggests additional aspects. She refers to several studies which have shown that while in elementary school boys and girls often do not differ in the enjoyment of the computer this tends to change in high school. One reason could be that girls rather see it as a tool to accomplish specific tasks and do something useful and relevant, and besides this prefer direct social contacts. In addition, it had turned out that many girls prefer educational approaches that are authentic and realistic with material that is presented to help them build a personal connection to the subject, and most of them like working cooperatively. Boys on the other side view computers rather as toys using them frequently at home to play games with friends and surf the Internet (see e.g. Schmidt 2001). For learning, many favor a competitive teaching approach. A specific finding from a didactical perspective is that girls seem to gather descriptive knowledge best when animation and graphics are used. If we suppose that the majority of technology classes are run in a ‘masculine’ style using only text to teach content, focusing rather on analytical approaches and favoring a competitive learning environment these mechanisms are most likely to prevent girls from establishing a connectedness with the material and their environment and a feeling of relevance. This might be a comprehensible reason for them not to enroll in technology courses (see also Kirkup 2002). If teachers do not pay attention to potential differences in the learning styles of their pupils and students most girls and women are unable to excel in these subjects and may therefore

not feel welcomed. Smith Keller (1992, 29) warns that the different perspectives, women and girls bring to the subject of technology, and specifically also to computing, will be seen and treated as inferior from the general masculine position. Rosser (2006, 13) underlines the situation by stating

> *"Although some funded, co-curricular, and pedagogical projects have explored techniques to attract women students and retain them in engineering curricula, none has significantly changed curricular content or affected, as one women engineer stated, 'the fundamentals'."*

Wasburn/Miller (2006, 61; see also Bath et al. 2008) hold these mechanisms liable for the fact that by the time girls and women need to decide their careers they have less experience with technology and computers and perceive themselves to be behind which again decreases their likelihood of entering a technological field and gaining acceptance in the university environment. The absence of women faculty and mentors, female peers in class and the lack of supportive networks add to this overall *"chilly climate"* (Wasburn/Miller 2006, 61). According to McKinsey (2007) 64% of women see the absence of female role models as a barrier to their development (see also Novak/Simonitsch 2010).

When looking at what happens after school and university we arrive soon at the discrimination of women which is still going on in the workplaces of today. One trigger – even in the 21st century – is the persistent social assignment of domestic tasks to women. As an equal share of homework and childcare between spouses is still rather the exception than the rule these tasks often restrict women's ability to fully participate in the labor market and force them into much lower paid, part-time jobs where their contributions are often undervalued. Factory and office automation and the chain-reaction of being pushed aside by men who themselves got marginalized by machines and computers (see also chapter 3.1.2.1) constitute a vicious circle of getting downgraded into more deskilled jobs and suffering from professional disadvantages (see. e.g. Feldberg/Glenn 1983). In characterizing the contemporary working conditions of many women in lower-level jobs, Webster (1996, 25) states:

> *"I view women's relationship to technology as one of exclusion through embedded historical practices reinforced and reproduced in contemporary work settings. Women at work suffer the double oppression of being both workers and women, contending with two interlocking systems of domination in which capitalism and patriarchy are by turns prominent in dictating the conditions of women's work."*

But professional discrimination is not restricted to the 'lower class' types of jobs. Meg Urry (2010), a professor for physics and astronomy at the Yale University describes the subtle – and sometimes also rather direct – mechanisms of discrimination and suppression she has experienced throughout her professional career as *"continuous drumbeats of under-valuation and the feeling of being unwanted"* (Urry 2010, 10). They ranged from mumbled comments at dinner meetings about women *"being only there because of the quota"*, to sexist jokes, to sarcastic comments about her pregnancy ("*ok, you obviously want to have it all!?*"), to passing her over with regard to promotions, to unjust criticism of work results and much more. Urry portrays specifically physics as a very hierarchical, aggressive and male-centric domain – she nicknames it *"combat physics"* – and describes physicists as characters who strive to and behave like being smarter than everybody else around them (ibid.). In this context, Fox-Keller (2005, 81) points to the fact that still today the association of masculinity with science and scientific thought is somewhat self-evident and rarely criticized outside the feminist environment (see also Scheich 2010). As a result, women are still massively underrepresented in technology leadership positions (Schraudner/Lukoschat 2006, 10). Given that this is rather the norm than the exception it is understandable that many women decide to leave such hostile environments.

In summary, different childhood exposure to technology, different educational approaches to boys and girls, a lack of female role models, the extreme gender segregation in the job market, different domestic responsibilities and historical processes of expulsion combined with discriminatory practices in the workplace lead to *"the construction of men as strong, manually able and technologically endowed, and women as physically and technically incompetent"* (Cockburn 1983, 203; see also Vuocco/Berg 2006; Wasburn/Miller 2006).

3.1.2.4 Gendered Design Processes and Artifacts

The prevalent male dominance in engineering and technology design often results in a gender bias of the artifacts as illustrated by the voice recognition and airbag fiascos described earlier, and becomes manifest also in the negligence of the needs and requirements of certain user groups as pointed out in the example of the 'smart home' (see also chapter 2.1). Another important instance of ignorance is the area of construction engineering where the designers still often lack social know-how, e.g. about the daily routines of women with children. Engineers tend to reduce their projects to technical issues eliminat-

ing ‘disturbing factors’ like users. The results are buildings that meet the latest technical and energy efficiency requirements but lack practical features like spaces for washing machines or windows at the right places allowing mothers to watch their children at the playground while cooking (see e.g. Schultz/Hummel 2002; Wächter 2002).

Designers – often implicitly – also make ‘gendered assumption’ about users which are then being translated into the technologies and products. An interesting study about that notion of gender in artifacts was done by Cockburn/Ormrod (1993) in the context of the design, development, testing and marketing of the microwave in the UK. The original main target group were single men who just want to quickly warm up a meal, and the first version of the microwave was designed and marketed as a ‘brown good’ – a domestic electronic ‘fun’ equipment on the same level as hi-fi – to meet the ‘masculine’ affinity for high-tech toys. Later, the product was redesigned and marketed as a ‘white good’ – a domestic, prosaic utility equipment – with more complex cooking options, and targeted family households and women who were supposed to do more cooking and be thus more interested and skilled in working with the new features. This example also shows how the gendered design of artifacts in return tends to reflect and reinforce gender stereotypes.

In addition, designers – consciously or unconsciously – tend to construct representations of targeted users considering their own preferences and skills to be representative of those of the future users. This so called *“I-Methodology”* (Akrich 1995, 173; see also Rommes 2006) leads to the production of technology scenarios or ‘scripts’ which reflect the interest and capacities of their creators – mainly young, middle-class men – and exclude women and other groups of under-represented users who lack these skills from being able to deal with the results (see also Oudshoorn/Pinch 2005, 10). In their analysis of gender in the design of the *“Digital City of Amsterdam”* (DDS) project Rommes et al. (2001, 241ff) describe these unconscious gendering processes and come to the somewhat astounding conclusion that even if women *do* form a major part of the design team, project results can still be gendered neglecting the needs of female users. This is remarkable given the idealistic designers of DDS coming from different disciplines wanted to explicitly create a system accessible to everybody, even without specific technical skills. Yet, the result were processes and a product that was gendered at various levels: At the *structural level*, DDS represents a gendered division of tasks with most of the programming being done by young, IT-educated men and ‘hackers’ while the women in the team had the creative and assisting positions. The prevalent user-representation technique was the

I-Methodology applied by the male programmers. Although founded by a woman and with more women being active in programming in the beginning, the mixed team came back to the 'classical' division of tasks, and the setup did not result in extra attention being devoted to the position of female users. At the *symbolic level*, the design practices reflected the masculine notion of using technology for excitement and adventure and designing it for its own sake, rather than for practical purposes. At the *identity level*, the designers were *"fascinated with all the new technical possibilities of computer networks, and endowed with a masculine learning style"* (Rommes et al. 2001, 256) making the software more complicated and adding additional functions expecting the user to adopt this style, read a complicated handbook and learn by playing around with the website, tools and functions. As a result, the project incorporated a clear gender-script and missed its objective to design a portal accessible to everybody – instead DDS was a technology *"accessible for everybody who has worked with a computer"* accommodating male rather than female users (ibid., see also figure 14). Oudshoorn et al. (2004) describe a similar community scenario and gendered consequences with regard to the private sector project 'New Topia' run by Philips Research.

Figure 14: Digital City of Amsterdam – A Virtual World for the Tech Savvy
Source: http://www.dds.nl/dds/jarig.php

Design choices until today have also often been made based on class and economic considerations resulting in clearly gendered, 'political' artifacts. One example is the blocking of women to skilled printing jobs by means of the male-dominated Linotype machine as described in chapter 3.1.2.1. Another brilliant instance of deliberate class discrimination is highlighted by Winner (1999, 30), in citing from Robert Caro's biography of Robert Moses, New York's master architect and builder from the 1920s to the 1970s. Moses amongst others built in limitations into the bridges over the parkways on Long Island to restrict access for unwanted visitors – with consequences being noticeable still today (see figure 15):

> *"Robert Moses, […] had these overpasses built to specifications that would discourage the presence of buses on his parkways. White upper- and middle-class car owners could use the parkways […] Automobile-owning whites of 'upper' and 'comfortable middle' classes […] would be free to use the parkways for recreation and commuting. Poor people and blacks […] were kept off the roads because the twelve-foot tall buses could not get through the overpasses. One consequence was to limit access of racial minorities and low-income groups to Jones Beach, Moses' widely acclaimed public park."*

Figure 15: A View to Jones Beach – Gendered Access Restrictions
Sources: Google Images and http://www.nyc-architecture.com/BKN/BKN001.htm

Rosser (2006, 18f) points to the fact that current intellectual property rights and agreements support such gendered choices in technology development and further exacerbate class differences. New technologies are often developed using public money in form of federal grants, and *"capitalist interests in profit margins"* (ibid.) steer the choices about which kind of products get developed and later transferred from the public who paid for it to private companies or individuals who control the patents.

While it is important to explore the various ways in which design processes and artifacts are gendered, it is also important not to oversimplify this theory but to use it as a means to critically evaluate the processes and results and to understand the social relations and gender contexts surrounding them. As shown in this paragraph, there are definitely many products and artifacts which do manifest masculine, class and economic interests in a material way, others are rather gendered by association and symbols, and again others might not be gendered at all (see also Faulkner 2000, 88).

3.1.3 **Hidden From History**

As pointed out in the last chapters, there are multiple reasons for the underrepresentation of women in scientific and technological fields – many of them are grounded in the Western social, political and religious culture having restricted women's education and the realization of their scientific and technological careers over the last centuries. Yet, while there have been indeed significant female contributions to the fields of science and technology they are rarely mentioned in any historical work or publication. As Wajcman (1991, 15) notes: *"Women's contributions have by and large been left out of […] history".*

3.1.3.1 Patterns of Marginalization

Women have been kept from higher education and the academic life and institutions by law and social norms as they were prevented from being officially recognized for their scientific discoveries and technical inventions (see e.g. Scheich 2010; Herring 1999). Specifically with regard to their perceived absence as technical inventors one needs to know that until fairly recently women in Europe and the US could legally only produce or market an invention under the name of their husbands or a male family member given their limited property rights. Even though, theoretically, the patent could have been filed

under a woman's name she would have been likely to refuse this having it rather filed under her husband's name due to social pressure. So, most women neither received the financial benefits nor the public credit for their inventions (see also Wajcman 1991, 15f). When looking at the literature on the history of technology, women's contributions seem to have been systematically left out with the prototype inventor being depicted as male – a phenomenon which is amongst others impressively demonstrated by Joan Rothschild's (1983, xii ff) analysis of *"Technology and Culture",* the leading journal in this field. A survey of articles related to women and technology yielded only *four* results – in twenty-four years of publishing! The bias towards male figures and the absence of women's perspectives in this important publication is also being criticized by Staudenmaier (1985, 180). Two decades later, Kvasny et al. (2005) reconfirm still the same tendency in their analysis of women and gender-related articles in five of the top-fifty information systems journals.

In the historical review of science, similar mechanisms of ignorance can be analyzed. Pelz/Andrews (1966) in their comprehensive publication *"Scientists in Organizations"* – even when talking about 'heterogeneous samples' – only refer to different categories and roles of male scientists and researchers. Fox-Keller (1987, 35f) describes as an additional phenomenon that many women, when they finally had got access to scientific institutions, sought to deliberately eradicate any distinguishing characteristics that might mark their gender in order to avoid discrimination with regard to their 'otherness'. This included withholding their first names from publications making them literally invisible, as the numeric representation of female scientists could no longer be counted in the statistics. So by the mid 1950s, women scientists in the US and in Europe seem to have disappeared. Given this obviously distorted image, it has been a key task of feminist authors to correct this impression and uncover those women hidden from history who have substantially contributed to scientific and technological development.

3.1.3.2 Great Women in Science and Technology

Looking at the history of science, there is an impressive account of female scientists who produced groundbreaking results (see e.g. Gupta 2011; Herring 1999), for example *Marie Curie* and her daughter *Irene Joliot Curie* who both won Nobel Prizes for their work in chemistry and radioactivity in the early 19th century, *Williamina Paton Stevens Fleming* who became the first honorary female member of the Royal Astronomical Society in Lon-

don in 1906 for her invention of a new classification scheme for celestial bodies which has been named after her and is still being used today (see Pitzen/Tscherner-Bertoldi 2010, 69), *Anita B. Roberts*, a molecular biologist who in 1942 discovered the protein TGF-Beta which plays an important role in healing wounds and fractures as well as in cancer therapy, *Stephanie Kwolek* who discovered and patented the polymer solvent that lead to the development of Kevlar in 1966, *Barbara McClintock* who in 1983 won the Nobel Prize for her work in cytogenetics, *Christine Nusslein-Volhard*, who also won a Nobel Prize for research on the genetic control of embryonic development, or *Rita Levi-Montalcini* who won another Nobel Prize in 1986 for the discovery of the Nerve Growth Factor – at the age of 99!

In her book *"Mothers and Daughters of Invention"* Autumn Stanley (1993) proposes that women who were responsible for gathering and processing food, producing clothing and caring for the young, old and sick since prehistory must also have been responsible for many of the anonymous technical inventions of these times. In an earlier publication (1983) she already pointed to several myths, e.g. from Australia, New Guinea, or Siberia, that show women as the first possessors of fire and thus also as the inventors of the process to generate and keep it. As society advanced, many inventions made by women could be identified in the areas of home, cooking and health even within the limited records found in the patent offices. In the 19th century, many patents were filed in the area of food processing devices, for example by *Emeline Hart* who patented the first commercial oven in 1876, by *Amanda Theodosia Jones* who developed the vacuum canning process to preserve food in 1873, or by *Mary Engle Pennington* who worked on an industrial freezing process and became one of the first members of the American Chemical Society. In the field of healthcare, *Anne Pike* is known for receiving an early patent for an anti-itch ointment as early as 1760. Many other treatments and medical instruments are known to originate from women's development but never got patented. Most of the medicine produced by female inventors contained natural ingredients some of which have proved to be curative until today. In the area of mechanics – although often ignored and attributed to men – women have a long history of inventing and contributing to the invention of sophisticated machines, e.g. in the area of printing technology or industrial design, sawing and reaping machines, small engines, the sewing machine or the Jacquard loom. *Sarah Jerome* received two patents for lumber cutting devices already in the 1630s, and *Tabitha Babbitt* invented the circular saw around 1810. *Sarah Mather* patented a subma-

rine telescope in 1864, and *Henrietta Vansittart* invented an improved screw-propeller for ships in 1868 – she is also said to be the first woman in the US who started and won a patent suit. *Emily Tassey* invented and apparatus for raising sunken vessels for which she got four patents in 1876. *Eliza Murfey* received 23 patents between 1870 and 1875 for materials and processes for packing journals, bearings and pistons in steam engines.

In the 20th century with improved educational possibilities more women got employed and their contributions more widely accepted. In 1939, *Beulah Louise Henry* (see figure 16) made about 50 individual inventions often developing the necessary tools and processes herself, without a specific technical background. Nicknamed 'Lady Edison' she even appeared in the Scientific American as one of their 'Outstanding Inventors'. Her first invention, a vacuum ice cream freezer got patented in 1912. One of her early inventions, an umbrella with a snap-on cloth cover to coordinate it with clothing, brought her enough money to set up a laboratory with staff and machines to turn her ideas into prototypes. In 1939, she got hired by Nicholas Machine Works as an inventor and run her own laboratory in New York. Until her death in 1973 she continued to innovate and by then was responsible for over 100 inventions including the 'protograph', a typographical device to produce an original and four typewritten copies without carbon paper, the bobbinless sewing machine, the 'Miss Illusion' doll with eyes that could change color and close, and the continuously attached envelopes for original and return mailings (see National Inventors Hall of Fame 2011).

The history of computer science, programming and the Internet has added famous names like *Ada Lady Lovelace*, *Adelle Goldstine* or *Grace Hopper* and many more to provide evidence that women played a major role also in this very recent chapter of technological history (Wajcman, 1991, 16; see also Repucci 2006; Kirkup 1992). While these are only a couple of rather random examples, the brief overview nonetheless shows that women's research, inventions and innovations were paramount to the development of Western society and industry and that the missing record in the history of science and technology is a result of a gendered perspective.

Figure 16: *'Lady Edison' - Beulah Louise Henry*
Source: Google Images

3.1.4 **Approaches to Solving the 'Women-Technology-Dilemma'**

As pointed out earlier, there is not the *one* feminist perspective, but several, partially interwoven strands arising from different political and ideological directions differing in their approaches to improving the relationship between gender/women and technology (see also chapter 1.4.1), The various schools of thought have been extensively reviewed by a couple of authors (see e.g. Wajcman 2009 and 2000; Brayton 2006; Faulkner 2001; Grint/Gill 1995; Karpf 1987). Concepts and questions shifted over time with changing theoretical and political positions, research topics and interests, and so did the measures proposed to narrow the gender gap with regard to technology. In the following paragraphs I will present and discuss some of the most influential approaches and show which proposals have been adopted by policy makers and by industry.

3.1.4.1 Liberal Perspective – 'Fix the Women'

The liberal approach focuses on the political dimension of technology and is the research framework usually found amongst policy makers (see e.g. Maass et al. 2007, 12f; Webster 1996, 22f). In the liberal tradition, women and men are regarded as being equal. Technology itself is taken as a given and not seen as value-laden, but it is understood as conventionally dominated by men, so one of the issues is the *"male control of neutral technologies"* (Wajcman 2009, 146) which makes women suffer from unjust discrimination. A key objective is thus the creation of equal opportunities for women. In order to help them to get out of their disadvantaged situation the liberal concept proposes economic, social and knowledge support, e.g. in the context of education or gender discrimination at work. Researchers within this tradition have tried to make women and their work visible in the history of technology and to demonstrate that there is no inherent difference disqualifying them from being competent designers of technology. Others have studied and proven discriminatory practices, e.g. legislation and selection criteria preventing women from entering technological fields or discrimination by teachers and peers in schools and universities (Maass et al. 2007, 13). Within this tradition, it is common to write about men and women, rather than about masculinities and femininities. Men are categorized as the norm to which women need to adapt in order to achieve gender equality. When all barriers are removed, they are supposed to become comfortable with the given situation and *"as active as men and in the same way active as men"* (ibid.; see also Hanappi-Egger/ Hofmann 2003).

The most important recent political initiative following the liberal tradition is 'gender mainstreaming' (see also chapter 1.4.2.2). The European Commission (2011b) defines this approach for all public and governmental institutions as follows:

> *"Gender mainstreaming is the integration of the gender perspective into every stage of policy processes [...] with a view to promoting equality between women and men. It means assessing how policies impact on the life and position of both women and men – and taking responsibility to re-address them if necessary [...] creating space for everyone within the organizations as well as in communities to contribute to the process of articulating a shared vision of sustainable human development and translating it into reality."*

Although material preconditions and resources to remove existing barriers are an important aspect for the inclusion of many women, the unconscious replication of the male norm in society specifically by means of political measures has received a lot of criticism (see

e.g. George 2006). McRobbie (2009, 152ff) specifically voices her concern vis-à-vis gender mainstreaming which is often promoted to be the political, institutionalized and *"less dramatic"* replacement of the feminist *"protest movement"* of past times. Concurring with Frey et al. (2006) she warns that the continuous dualistic idea of gender mainstreaming keeping intact notions of specific feminine and masculine capacities can end in a *"smart management of assumed differences"* putting women into certain areas, e.g. the service sector, where they are supposed to add value by virtue of their particular skills and competences. While the vocabulary of gender mainstreaming is *"modern, managerial and professional"* (McRobbie 2009, 155) she takes up a socialist stance and points to the danger that this concept could be *"absorbed and taken on board by structures and institutions of capitalism"* as it was the case in earlier decades. Invalidating the argument of gender mainstreaming supporters that with more and more professional women entering key positions across the offices of the state these will make sure women's rights are given priority, she refers to the situation in the UK government under Tony Blair where women who had earlier demonstrated strong commitment to women's issues were completely muzzled, and feminist ideas were struck down and "*endlessly vilified […], and a swaggering macho style of government met with little or no opposition"* (ibid.).

As gender mainstreaming has been chosen by most Western governments as a way to overcome the women-technology gap there needs to be a wider debate about options to improve the shortcomings of this rather technocratic way of dealing with women's issues (see also Stiegler 2008).

In industry, corporate decision makers have also long believed that the best way to integrate more women into the technology workforce is to treat everybody in the same way, thus specific efforts have been made to support female employees to fit into male career models and leadership styles. Activities in this context usually run under the 'diversity' umbrella and are translated into initiatives that mainly aim at helping minorities to adapt to the prevalent male norm in companies (see e.g. Wittenberg-Cox/Maitland 2009, 20 ff; also Wittenberg-Cox 2010; Bruchhagen/Koall 2008). Besides treating female employees as a minority among many others they are also regarded as the ones who need help to become more competent (see also Priddat 2004, 171). Thus, these initiatives can also reinforce stereotypes by over-emphasizing issues like work-life-balance and child-care as a specific women's problems. Figure 17 is a little sarcastic side blow to visualize such inherent male comportment.

In summarizing their doubts about these current approaches, I absolutely agree with Wittenberg-Cox/Maitland (2009, 20) when they state:

> *"Companies that limit their gender initiatives to networking or development programs for women miss the bigger picture. This kind of "fix-the-women" approach focuses its efforts on the wrong segment of the population. Women don't need "fixing". Most of the attention and money given to this would be better spent on fixing the systemic issue of outmoded corporate attitudes and processes."*

Figure 17: Adapting to the Norm
Source: Wittenberg-Cox/Maitland (2009)

The concept of equal opportunities as the central theme in liberal feminism has certainly many good aspects. Yet, overall, it also implicitly bears the danger of cementing the state of the art of a male-dominated technological worldview. The challenge is to promote equality without assuming sameness and to support gender diversity without reproducing unwanted inequalities (Sørensen/Lagesen 2008; see also Schulze Buschoff 2010). Although liberal feminism suggests that an equal share of women in the technology workforce would correct the bias in design and better serve women's needs and interests Rosser (2006, 16) believes that it *"reaffirms rather than challenges positivism suggesting*

that 'fundamentals' would always remain the same". Yet, with an increasing amount of women coupled with a heightened awareness of the potential bias in design or user-friendliness, she also expresses hope that both male and female engineers and technology creators can correct such biases that previously resulted from the failure to include women and their needs and interests. With regard to political programs Maass et al. (2007, 13) claim that rather than forcing women to adapt to a given norm by pushing policies through, *"the relevance and pleasure of creating and using technology for individual women need to be clear"*.

3.1.4.2 Radical and Socialist Views – Change the Standpoint

In contrast to the liberal approach which deems technology itself as neutral and looks at the political dimensions, both radical and socialist feminism have analyzed the gendered nature of technical expertise and put the spotlight on the artifacts themselves. Women and men are seen as fundamentally different – either because of biological reasons or by socialization – and women as having been systematically dominated and controlled by men. The problem is not only men's monopoly of technology, but also the fact that gender has become embedded in technology itself. Western technological culture and artifacts are regarded as *"deeply implicated in this masculine project of the domination and control of women and nature"* (Wajcman 2009, 146). A specific notion of this radical perspective is being voiced in Ecofeminism which stresses the dualist, essentialist categories of 'women = nature' and 'men = technology' with masculinity being the synonym for the hostile control and domination of women and the environment (Webster 1996, 22f). This approach has amongst others been influential in the 1980s discussion around technologies of human biological reproduction, like e.g. in-vitro fertilization, to which radical feminists strongly opposed fearing a *"patriarchal exploitation of women's bodies"* (ibid.).

While this strand was focused on women's physicalness and sexuality, socialist feminists had put their interest on the relationship between women's work and technology revealing that the sexual division of labor and the gendered nature of work processes and artifacts as we see it still today has not happened by accident, but as a consequence of the interplay of capitalism and patriarchy as well as of the male domination of skilled trades that developed during the Industrial Revolution (Wajcman 2009, 147; Webster 1996, 23f; see also chapter 3.1.2.1).

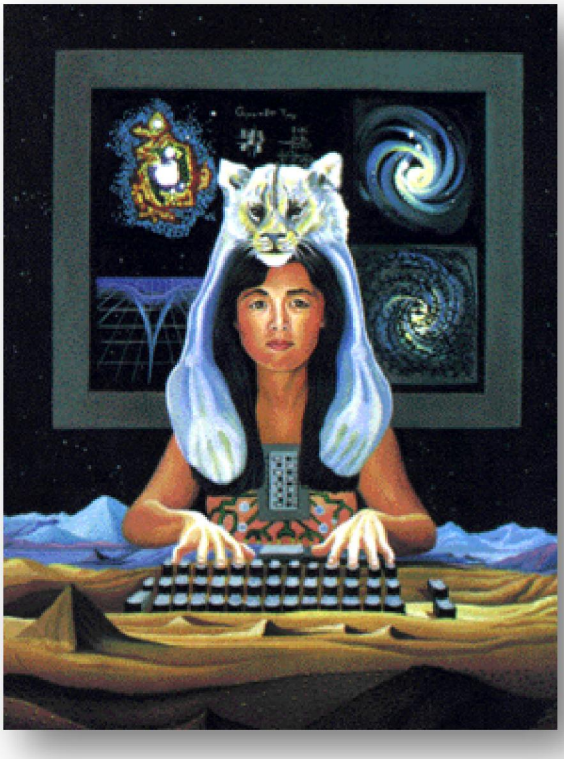
In the current discussion around overcoming the gender gap a main thesis is that female connotated characteristics, skills and values need to be revalued and regarded as at least equal if not superior to male connotated values and skills, and technologies and technical cultures need to be adjusted to feminine requirements (see Maass et al. 2007, 14). Examples are improved education and training approaches based on feminine learning styles, and a focus on 'relevant' content. The theory assumes that the current lack of women in technology is the result of a lack of interest and a rational choice and concludes that by making technology more approachable and relevant for women they will automatically find it more attractive to get engaged in the subject. Hence, inclusion will be achieved by changing technology, not women. With regard to the technology design process, Maass et al. (2007; see also Rosser 2006, 19) stress the necessity to make the designer standpoint and its commonalities and differences with user standpoints explicit to make sure technologies become attractive to a wider diversity of users, including those with female connotated interests, values or characteristics. This thought can be found for example amongst managers of companies who want to get a better understanding of the needs of their female customers. A major disadvantage of strategies based on such a *standpoint epistemology*, especially if 'women' and 'feminine connotated interests' are regarded as the same, is that essentialist stereotypes may also be reinforced. In designing for so called 'female values' (e.g. specific simple interfaces or 'pink' products) gendered technological subjects may again be the result.

A specific criticism which is voiced both with regard to liberal and to radical and socialist perspectives including ecofeminism is their predominantly pessimistic notion concerning the possibilities of redesigning technologies for gender equality and *"the role of women's own agency in formulating their relationship to technology"* (Webster 1996, 24; see also Wajcman 2009). Webster (ibid.) analyzes a certain *"hopelessness"* in these approaches that define policy makers as the main change agents seeing ordinary working women as simply responsive and passive, and that deem "*opting out altogether"* more or less the only way for women to escape the masculine technology domination. In contrast to this pessimistic perspective, feminist approaches of the 1990s with the advent of the digital age were much more optimistic with regard to the possibilities of information and communication technologies for the empowerment of women and the transformation of gender relations with regard to technology. I will briefly summarize the ideas of this strand in the next paragraph.

3.1.4.3 Cyberfeminism – New Technologies = New Opportunities !?

The cyberfeminist motion explores the ways in which new technologies and the Internet may liberate (or oppress) women by means of opening up new routes for reconstructing feminist politics, creating better job opportunities and outlets for creativity (see e.g. Kailo 2006; Rosser 2006, 38). Many authors have dealt with this topic and almost all of them refer to Donna Haraway's (1999; 1991) *"Cyborg Metaphor"* to sum up the general optimism of post-feminist literature that women are *"uniquely suited to life in the digital age"* (Wajcman 2009, 148; see also Graham 2001). Haraway acknowledges the great power of science and technology, specifically the new digital technologies, to create new meanings and entities – *"a new feminist 'imaginary' different from the 'material reality' of the existing technological order"* (Wajcman 2009). Haraway's ideas are too broad to dig much deeper here, but I share some fragments from the *"Cyborg Manifesto"* (1991, 149ff) to convey an impression of her extraordinary imaginary force – see figure 18.

Developments in digital technologies have changed the processes of technological innovations as well as business models and the cultures and practices of everyday life. Yet, the optimistic expectations that sexism, racism, capitalist materialism and other oppressions would cease to exist in the virtual world have not come true. While women have indeed been more actively engaged with the new media and have gained additional niches of freedom and opportunities for self-expression (see e.g. Joost et al. 2010), gender and power relations of the material world have at the same time largely found their ways into the Internet where capitalism can now operate on a global scale much more easily, sexism has become manifest 'online' in various forms, and the gendered segregation of work has persisted (see e.g. Vendramin et al. 2001, 53; Brosnan 1998, 170; for a closer evaluation of the optimistic perspective see e.g. Woodfield 2000).



" This is an effort to build an ***ironic political myth*** *faithful to feminism, socialism, and materialism. […]* ***A cyborg is*** *a cybernetic organism,* ***a hybrid of machine and organism,*** a creature of social reality as well as a creature of fiction. *[…] By the late twentieth century, our time, a mythic time, we are all chimeras, theorized and fabricated hybrids of machine and organism; in short, we are cyborgs. The cyborg is* ***a condensed image of both imagination and material reality,*** *the two joined centres structuring any possibility of historical transformation. […] Cyborg imagery can help express two crucial arguments: first,* ***the production of universal, totalizing theory is a major mistake*** *that misses most of reality […] and second, taking responsibility for the social relations of science and technology means* ***refusing an anti-science metaphysics,*** *a demonology of technology, and so means embracing the skilful task of* ***reconstructing the boundaries of daily life,*** *in partial connection with others, in communication with all of our parts. […] Cyborg imagery can suggest a way* ***out of the maze of dualisms*** *in which we have explained our bodies and our tools to ourselves.[…] It is an imagination of a feminist speaking […] It means both building and destroying machines, identities, categories, relationships, space stories. Though both are bound in the spiral dance,* ***I would rather be a cyborg than a goddess.*** *"*

Figure 18: Excerpt from 'Cyborg Manifesto'
Source: Donna Haraway (1991)

A general finding from all approaches reviewed so far is that in the end neither technology as such can be condemned as inherently patriarchal with only negative implications for women, nor is it an unambiguous means of liberation as hoped for by some cyber-feminists. Instead, both the overall conception of technology and of gender need to be approached in a different way, which will be the tenor of the next paragraph.

3.1.4.4 Social Constructivism – Things Could be Otherwise

Over the last two decades, feminist analyses of technology have theorized the relationship between gender and technology as one of mutual shaping. Based on the conviction that human reality is a socially constructed reality (see e.g. Berger/Luckmann [1969] 2010) technological innovation is believed to be shaped by social circumstances and vice versa. Technology is seen as a sociotechnical product combining artifacts, people, organizations, cultural meanings and knowledge – being both a source and consequence of gender relations (see e.g. Wajcman 2009; Hackett et al. 2008; MacKenzie/Wajcman 1999, Bijker et al. 1987). Today, most researchers within gender and STS have adopted this social constructivist framework that considers gender and technology as co-constructed (see also chapters 3.1.1 and 3.1.2). Consequently, they make attempts to deconstruct and redefine both 'femininity' and 'technology' to show the instability of stereotyped categories and patterns, for example by analyzing the many individual experiences that oppose gender and technology dichotomies, by revealing how language, representations and images influence identity formation, by making visible the domination and masculine connotated values in the teaching of technology or by retracing the semiotic and historical roots of the categories to show *"how they are the result of contingencies"* (Maass et al. 2007, 15). Examples of research questions to deconstruct the designer/user divide and that between production and consumption are (ibid.):

- *What values are present in society and inscribed in technology?*
- *With what kinds of assumptions and values about technology, users and the society do designers work?*
- *Whose values and experiences are represented and what dichotomies and stereotypes are repeated in technologies and technological culture?*
- *What gendered subjects are being (re)produced in work situations through (in-) formal teaching situations or by becoming a user or a designer of technologies?*
- *How do gendered interactions in classrooms lead to gendered design choices?*
- *How did the interactions between designers lead to gendered design choices?*
- *How do the biographies of women interested in technology or female engineers look like?*
- *How do users adopt gendered technologies?*

Policy makers and designers who follow the social constructivist line of argument in order to explain the gender gap in technology have tried to disconnect the linguistic and symbolic links between technology and masculinity. Researchers have introduced qualitative methods like narrative and discursive approaches (see e.g. Ahl 2004; Hjorth/Steyaert 1994). This framework does act on the assumption that there are neither stereotypical male/masculine or female/feminine attributes nor is there one single strategy that would work to include 'all women'. Instead, actions and artifacts need to be designed paying attention to local, contextualized knowledge, and designers should be encouraged to choose adequate design methods attempting to dissolve the boundaries between designers and users (see e.g. Rommes 2006).

The last chapter has shown, how diverse feminist and gender research approaches to technology can be, and that elements of certain strands may vary and overlap with others. Criticism of individual aspects of previous theories has often led to more comprehensive approaches compensating for the criticized factors and adding new findings and insights. Looking back at the exploration I have undertaken so far the following quote from Murray (1993, 64) describing his attempt to embrace the relationship between science, technology and masculinity partially also reflects my findings and feelings along this journey:

> *"A more apt analogy might be to stumble around the dimly lit broom cupboards of my own and other peoples work and experience. In the process I feel I've disturbed a lot of dust. Emerging back in the light I find I've gathered a handful of jigsaw puzzle pieces. The pieces won't fit together and I wonder if they are from different puzzles. The different pieces are suggestive of different themes. Perhaps they are equally important, perhaps the broom cupboards were built by post-modernists, perhaps there is no one perspective that can hope to explain the multi-faceted relationship of technology, science and masculinity. This emerging realization has been irritating and confusing; I am not immune to the desire to make a coherent picture, to fix it in time, and distil complexity and uncertainty into a solid and totalizing theoretical framework."*

Yet, taken together, I find that the spectrum of feminist theories and approaches to explain and tackle the gender-technology issues provides a wealth of insights and ideas, and I concur with Maass et al. (2007, 17) that we can gain something valuable from each of the perspectives which allows us to take better informed decisions with regard to further actions: The liberal approach teaches us to pay attention to the barriers women face in getting engaged with technology, to patterns of exclusion, and to the impact, technology has on our lives. The radical and standpoint perspectives highlights the advantages of consi-

dering female connotated values, e.g. with regard to the objectives and priorities that are supported by technologies, and the hidden norms shaping ourselves and society. Cyberfeminism and specifically the visions of Donna Haraway open our minds to what might be possible if we allowed ourselves to think outside the boundaries of traditional dualisms using our imagination. And finally, the social constructivist approach increases our awareness of the importance of language and symbols and of the options to look behind the scenes of values, stereotypes and dichotomies that are presented as universal and given, as well as for the mechanisms of gender and technology co-constructing each other.

At this point, I conclude the comprehensive discussion of the general relationship between gender, women and technology and will focus more closely on the specifics of gender and information technology/computer science.

3.2 A Closer Look at Information Technology

Besides analyzing the gendered nature of technology at large I would like to put a special focus on the question of gender and information technology as it leads me further towards the question of whether and how gender awareness is a factor in software design. Being mainly interested in the software portion of IT, I will not specifically go into questions of computer hardware unless necessary for explanatory purposes.

3.2.1 **What makes IT Special?**

As pointed out in the introduction, IT has a special status with regard to other technologies as it provides manifold opportunities for transforming professional and private lives, individual and social interactions, educational directions and economic as well as technological developments. The European Commission (cited in Webster 1996, 7) defines Information Technology as

> *[...] the interconnection of technical and organizational innovations in [...] computers, software engineering, control systems, integrated circuits and telecommunications, which makes it possible to collect, generate, analyze and diffuse large quantities of information at low cost."*

To emphasize the specific social relevance of IT the EU in their 6th Framework Program coined the term *"Information Society Technology"* (IST), and the UN World Summit for the Information Society published the following principles (WSIS 2003):

> *"We, the representatives of the peoples of the world, […] declare our common desire and commitment to build a people-centered, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life, premised on the purposes and principles of the Charter of the United Nations […]."*

3.2.1.1 The 'Black Box Phenomenon'

A strong contrast to this vision of inclusion is being formed by the fact that about 50 percent of the overall Western population suffer from *"technophobia"* which becomes manifest in feelings of computer-related fear and anxiety (Brosnan 1998, 171). While IT is actually supposed to make life simpler by providing more and more functions to execute even more tasks, it unfortunately at the same time complicates life by increasing complexity and making it thus harder to learn and to use the technology (Norman 1990, 31) – a fact which amplifies many people's aversion still further. From my own experience I can provide anecdotal evidence that my motivation to use a technological gadget decreases proportionally with the increasing size of the manual I have to read upfront.

There is no other technology where the gap between the experts and the users is so large and the 'black box' between design, input and output so hard to grasp. *"Software is a symbolic representation of the world, and only technically skilled people are able to envision the model the symbols refer to"* states Bratteteig (2002, 94) in explaining how software differs from other symbolic representations, like e.g. an architect's drawing, in that it is at the same time the basis for program execution. While the architect's model can be easily understood also by non-experts and can be realized in tangible material like wood or stone, in IT both the 'drawings' and the realization are the same type of symbolic representation and can thus not be captured by a non-expert. As computers are machines, the artifact – the final product 'user software' – is not finished until the program can be executed. Before, it only exists as static representations of texts and graphics. *"Interpreting the representations means envisioning the running program execution and requires knowledge about system description languages and programming languages and computers"*

(Bratteteig 2002, 96; see also Tellioğlu 2001). With regard to this specialty, Bratteteig/ Verne (1997, 11) argue that a key skill for computer scientists and software engineers needs to be an understanding of the uses and applications in order to generate a better idea of the consequences for and conditions of the users' experiences:

> *"An adoption of this view will have great implications. It implies turning the internal status structure among the practitioners upside down, such that solely technical expertise might be seen as limited instead of brilliant. This change would be fundamental to the discipline, and would require more than just discussing use and consequences as an addition to technical stuff."*

An often rehashed joked which is exemplary for the expert-user divide in IT is the alleged conversation between a support staff and a user who in IT slang is classified as a D.A.U. (which stands for 'dumbest assumable user' and shows the mindset of many experts who cannot imagine that problems of use might not result from a user's lack of intelligence but from a different perspective – see also Bannon 1991, 29). The IT support person asks the user at a certain point in the conversation and for a certain operation to hit 'any key' on his keyboard, and the subsequent question of the user where the 'any-key key' can be found has become legendary history leading to many jokes like the one in figure 19.

Figure 19: D.A.U. Keyboard
Source: Google Images

3.2.1.2 Dictating Most People's Working Lives

The objective of most computer systems is the automation of tasks in the working environment which "*have in the past and still could be, performed by humans"* (Pain et al. 1993, 11). The scale and the extent of this automation have increased dramatically over the last decades, and today cover almost all working areas and company sizes – from very small firms to multinational corporations, from 'simple' accounting functions to complex business analytics, from shop floor integration to mobile cloud-based application provisioning. Complex information systems gain an increasingly important role and a significant impact on billions of people's working lives. What was done manually and with a lot of human interaction and communication in the past is now executed by a computer operated often in an isolated setting. Work patterns are being dictated by the system, and the users have little influence on the design processes. Standard systems development methods often support "*traditional management objectives of quantitative efficiency at the expense of people in the workplace"* (Bødker/Greenbaum 1993, 54; see also Machung 1988). Pain et al. (1993) describe how in the course of this development the key focus and limiting factor for further computerization shifted from hardware constraints through software constraints to the user focus in design in order to bridge the gap between specialist, expert developers and those having to live and work with their products.

3.2.2 **Gender and Information Technology**

The question of where to find gender in information technology and informatics is an interesting one, and it looks like the answers need to be discovered in between the opposing perspectives of some feminist scholars who deem IT an out-and-out male-dominated domain and the statements of some women working within the discipline claiming that science and technology are gender neutral (Bratteteig/Verne 1997; see also Miliszewska/Horwood 2000). Tellioğlu (2001; 2002b) draws our attention to the fact that with regard to the specifics in IT we need to be very clear about what we mean when talking about 'gendered technology'. She distinguishes between the components of the underlying software technology, like source code, application programming interfaces, or modeling tools which she classifies as gender-neutral, and the gendered patterns people follow when performing computer professions, like gendered computer education, gendered occupations, and gendered roles in designing applications and interfaces (see also Püchner

2009). To investigate the gender related issues in the context of IT we need to take a closer look both at the use and at the design processes. Users have their own understanding of IT as a tool to support their work and leisure activities, often without much understanding of the underlying technology, while for designers and developers IT is at the core of their work – they define the architecture and components, plan the methods and procedures to build the software and have an in-depth technical understanding. Until today, such 'experts' often judge the work processes of users in the business, specifically in the office space, as *"a series of trivial tasks done by women"* (Bødker/Greenbaum 1993, 58) completely neglecting the complex and socially interactive nature of these processes which are rich in problem-solving capacity (see also Maass/Rommes 2007, 106). Again, it is mainly men who as programmers configure applications with a direct impact on areas of work which are being primarily staffed with women due to the gender specific segregation of work (Winker 2002).

Trauth/Howcroft (2006) notice a surprising lack of critical literature on gender and IT. Standard positivist approaches discover *whether and where* there are differences (e.g. with regard to education and adoption rates) which are mainly looked at from an essentialist perspective and understood to arise from biological and psychological differences between men and women thus reinforcing existing stereotypes about a female lack of technical competence. Interpretative studies of gender and IT evaluate *how* these gender differences in IT professions and use have arisen. The focus is on understanding the societal influences in the relationship of gender and IT and the situation of women as users based on social constructivist thought and the idea of *"individual differences"* (Trauth 2002). Trauth/Howcroft (2006, 141ff) argue for an additional critical research perspective investigating *why* gender inequality exists in IT and for challenging the power relations by means of focusing on the gendered nature of the workplace and the current set of IT skills to *"shed theoretical light on the subtle ways in which gender inequality is operationalized"* (ibid.).

3.2.3 **The Absence of Women in IT**

As pointed out earlier, women remain a minority in the IT sector and are excluded from participating in the full range of potential jobs and careers. Statistics clearly show that there is a huge imbalance in IT professions with only about 17% female employees and a

declining pipeline of female IT students (see e.g. Bath et al. 2008; Birbaumer et al. 2006). Even though a positive trend has been recorded over the last decade concerning women's increased access and use of the Internet as well as with regard to the rise of applied information technologies (Herring et al. 2006; see also Wanless-Sobel 2006) – leading some to even argue that in the 21st century *"women's issues are a thing of the past"* (Sørensen/Lagesen 2008, 2) – their place in the Information Society including education and work experiences remains *"markedly different from men's"* (Vendramin et al. 2001, 53). Despite the emergence of new industries, sectors and business models the conventional gendered and social division of tasks – both in the spheres of paid work and private life – seem to reappear in our modern, 'digital' environment. Henwood (1993, 33) shows that the highest proportion of women in computer-related occupations is still found in low-level software jobs, specifically in data-entry functions, while only a very small number is represented in the area of high-level jobs like computer scientists, system analysts, or programmers (see also Woodfield 2000, 5f). Building on the findings in chapter 3.1, explanatory factors for the specific absence of women in the field of IT can be roughly subsumed under four categories (Vendramin et al. 2001; see also Webb/Young 2006):

3.2.3.1 Imbalances in Education and Training

The enrollment numbers in secondary and higher education clearly show that women are less interested in IT professions and remain largely absent from fields like computer science, software development, and the design of IT products in most industrialized countries (Sørensen/Lagesen 2008). It appears that students do not have a precise idea, but build their opinion based on the male dominated stereotypes picked up in the media, their earlier experiences with computers and computer classes and the impression they get from their parents behavior and attitude towards IT. Representatives of the discipline are seen as unattractive male hackers and 'nerds', and the professional life in IT as being shaped by a lack of social interaction (see also Bath et al. 2008, 823f; Teague 2002; Turkle 1988). School education systematically supports boys' learning preferences and strengths, and the courses are mainly taught by male teachers; female role models rarely exist. Informatics is associated with mathematics and physics rather than with tangible subjects like management and communication, thus many girls lack the practical relevance of the topic and feel it is too abstract and technical for them. Emphasizing the differences in gender-related learning and use of computers Brosnan (1998, 5) therefore

strongly recommends to evaluate all educational curricula and software with regard to gender appropriateness (see also Buche 2006). Several organizations on a national as well as international level have set out to tackle the issues of IT education in winning stakeholders from governments, industry and academia and launching joint campaigns and activities (see e.g. ECWT 2011b). A specific example to attract more girls to the subject of IT is the *"Cyberellas are IT"* campaign (European Commission 2009; see also figure 20) providing amongst others the opportunities for girls to 'shadow' successful IT women at their workplaces. Margolis/Fisher (2006; 2002) describe some of the activities that helped Carnegie Mellon University quadruple their female enrollment numbers in IT. Amongst them are mentoring programs and communities, a positive learning environment, a specific women group without the need *"to speak boy"*, painting a broader picture of the subject and ongoing interaction and communication with the students. They conclude (Margolis/Fischer 2006, xlvii):

> *"The goals should not be to fit women in computer science as it is usually conceived and taught. Instead, as we suggest 'Unlocking the Clubhouse', a cultural and curricular revolution is required to change the culture of computer science so that valuable contributions and perspectives of women are respected within the discipline. Ultimately, this revolution does not only serve the interests of the women involved, but those of the discipline itself."*

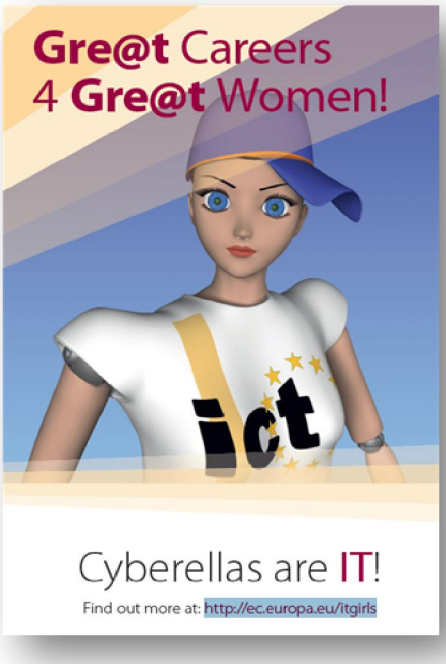


Figure 20: EU Campaign 'Cyberellas are IT'
Source: http://ec.europa.eu/information_society/activities/itgirls/doc/cyberella_poster.pdf

3.2.3.2 Disadvantageous Working Conditions

The intensive rhythms of work which are the reality in IT and expected by many employers frequently collide with most women's familiar situation. The working speed and the long hours combined with an unpredictable daily working time have a discriminatory effect on women who – other than most men without much domestic responsibility – often have additional familiar obligations and need to closely manage their time. Cringely (1992, 114) gives an impression of this general notion of IT employers at the example of a court case where Microsoft got sued for discrimination against married employees:

> *"At Microsoft, it's a disadvantage to be married or have any other priority at work […] According to a middle manager […] employees were expected to be single or live a 'singles lifestyle' […] the company wanted employees that 'ate, breathed, slept and drank Microsoft', and felt it was the best thing in the world."*

Especially in software projects, the pressure of the deadlines is high forcing the project groups to an ever increased intensification of work. Vendramin et al. (2001, 58) illustrate how this pressure to be *"the fastest and the first"* leaves no more space for extra-professional constraints. Longer periods of absence, like maternity leaves, prevent women from getting back into their previous roles, and part-time work does not fit with the overall working model. Although there is a shortage of skilled labor specifically in the IT industry the current job descriptions still paint a caricatured picture of a world composed of dynamic young people redlining older candidates, people with children, and specifically women. A study carried out in Germany confirms that the compatibility between professional and family life is the biggest obstacle in women's IT careers (Menez et al. 2001). Even if some employers now slowly start to offer improved patterns like part-time work or home office regulations to attract more women, overall not a lot will change with regard to working conditions in IT unless a much larger percentage of women is in the business and consequently forces employers to reshape their minds and processes.

3.2.3.3 Professional Discrimination

On top of the disadvantages women face with regard to working conditions in IT as described above, they also often experience prejudice and discrimination when it comes to career development. The increased requirements of geographical mobility in an environment which is characterized by reorganizations, downsizing and off-shoring decrease the

opportunities for a structured career planning. From an occupational perspective, the gendered division of labor which has been known from other branches has re-emerged in IT with men mainly dominating the technical areas and women to be found in low-status functions which often involve high levels of user interaction, like e.g. service and support roles (see e.g. Tellioğlu 2002a). Webster (2006, 42 in referring to Grundy 1994) states that the kind of computing work women have access to

> "[…] *is often rather the messy and concrete work which is similar to domestic childcare […] matching computer systems to reality and […] the needs of the end users while men monopolize the 'pure and abstract tasks', […] the 'virtual reality' which is not tainted by the demands and exigencies of the more ordinary work-a-day world."*

In addition, Women in IT – like in other branches – often earn substantially less than men (see e.g. Henwood 1993, 35) and face the phenomenon of the 'glass ceiling' (see e.g. Accenture 2006). The metaphor describes the apparently invisible barriers that prevent women from reaching senior management positions. Compared to formal barriers such as education, the glass ceiling refers to less tangible hindrances, frequently anchored in culture, society and psychological factors. Career progression in IT seems to follow masculine rules like attending meetings late in the evening, participation in clubs, joining male dominated leisure activities etc. from which women are mainly excluded. As a consequence, they often lack context and cultural information to understand the hidden agenda in the company, miss the opportunity to present themselves and their own vision of an informatics culture and are kept away from the strategic decision making (Vendramin et al. 2001, 60). Pringle et al. (2000) in their analysis of successful women in IT figured out that adapting to the male working environment was critical for the advancement of the interviewees but it meant participating in activities they did not have an immediate interest in and time for. As a result, women who do not adapt to this masculine culture often mention a lack of promotion and support by their superiors (see e.g. Menez et al. 2001). So in reality, the reasons for the career stagnation and constant salary differences in IT professions are often not grounded in women's technological aptitudes but rather in their problems adapting to the male organizational culture and a lack of mentors. As people have a natural tendency to stick with their peers, without an increased gender awareness the existing social *"Old Boys' Networks"* (Haynes 2006) will continue to promote a disproportionate number of men into the positions of power. Wittenberg-Cox (2010, 7) has coined the term *"gender asbestos"* to illustrate this phenomenon (see also figure 21).

Another peculiarity can be detected when it comes to qualifications: Comparable qualifications with regard to their male colleagues are normally not enough for a female career in IT. In addition to their informatics competences, women are usually expected to demonstrate their 'natural' social skills which in return places them often in support functions. While these skills do not lead to any extra credit, remuneration or recognition, men often manage to present such additional relational skills as add-on competences with a positive impact on their careers and salaries (Vendramin et al. 2001; see also Trauth 2002; Woodfield 2000, 105). McCracken (2000) in a case study about Deloitte & Touche which has a strong IT consulting unit observes that *"women get evaluated on their performance, men […] on their potential"*. Collmer (2001, 7) concludes (see also Priddat 2004, 170):

> *"Boys and men are viewed as technically competent and remain in this position until the contrary has been proved. Girls and women are seen as incompetent and also remain in that position until the contrary has been proven."*

Figure 21: 'Gender Asbestos'
Source: http://todayinsocialsciences.blogspot.com/2010/11/some-cartoons-about-glass-ceiling.html

3.2.3.4 Cultural Factors Reinforcing a Male Image

As outlined previously, women and girls often experience IT as an alienating, male-dominated and competitive culture early on in their education. The impact might range from feelings of isolation to intimidation and even worse (see e.g. Haynes 2006; Vendramin et al. 2001, 135). Overall, there is a very strong correlation between IT and high-tech and an exclusion of social aspects which maps the common Western gendered dichotomies (Bath et al. 2008, 823f). Kvasny et al. (2005, 15) point out how the social construction of women as *"technophobes disinterested in computers"* reinforces existing stereotypes (see also Brosnan 1998, 171f), and although there is the strong evidence of women being early and important contributors to the field of information science and technology (see e.g. Rosser 2006, 38) the general opinion in the IT industry, and specifically within the hacker culture, still sees women as the ones "*being on the outside"* (Döge 2002, 32). Due to apparent differences in women's and men's operational styles this notion is hard to correct as women often fear to appear aggressive or competitive. Ayre (2001, 17) states:

> *"[…] where men command, lecture and compete, women listen, talk, suggest and cooperate."*

Overall, I concur with Trauth (2002, 114) and all the other scholars in this field that while there is not the one female perspective, and the relationship between gender and IT participation and profession is not the same for all women, there are nevertheless *"common experiences across […] diverse cultural backgrounds reinforcing the social shaping of IT and the IT profession as a male domain"* (ibid.). Thus, there is a definite need for a deliberate 'gendered perspective' to be integrated into IT design and reflected every time information technology is being planned and realized.

In summary, it is safe to conclude chapter three with the statement that there is a strong cultural connection between masculinity and science and technology kept in existence by the *"masculine attempt to define itself by its monopoly control of reason, logic and objectivity"* (Murray 1993, 77) struggling to keep women out or forcing them to choose between their female identity and *"the membership of the science and technology fraternity"* (ibid.).

Woodfield (2000, 25 f) underlines these findings – referring to many scholars in the field – by listing her two key reasons for the masculine shaping of IT:

> *"The first reason […] is that the computer has come to occupy and increasingly important practical and symbolic position in the anticipated future progress of the societies […] As science was instantly recognizable as a potentially highly profitable enterprise, it was identified as a male province in accordance with the unmistakeable pattern whereby the most highly valued resources and practices in a society are appropriated by those with the most power.*
>
> *The second reason why computing has been absorbed into the 'male' scientific and technical domain so quickly, and absolutely, and has begun to express this fact in its culture, its artefacts and its inhabitants' typical behaviour, is because of the symbolic returns computers offer when taken up as signifiers of certain crucial aspects of modern masculinity. High-tech culture provides 'both a crucible and a core domain' (Murray 1993, 78) within which the social construction of a key stream of contemporary male identity can take place, and therefore operates in the self-same way that other areas of science and technology have served masculinities for hundreds of years."*

This statement can be enhanced for the IT professions concluding that women are underrepresented due to a number of reasons among them a one-dimensional masculine approach to IT education, professional discrimination, working models that do not fit most women's familiar situation, an unequal sharing of domestic tasks like child and elderly care, and the undervaluation of women's skills and competences (see also Ortlieb/Rokitte 2004). The overall familiar result is a stagnating number of female IT students leading to a lack of female IT designers causing the creation of 'masculine' applications which in return re-emphasizes the masculine notion of the overall subject keeping even more women from studying IT – a vicious circle that needs to be urgently breached (see figure 22).

Unfortunately, as raising gender equality issues is obviously not seen as a means for career advancement, promotion of gender equality in the IT sector does not receive sufficient top-level support and thus until recently did not reach the political level but remains to be championed by non-profit organizations and scholars, organized through networks of voluntary work (Marcelle 2006). One encouraging exception is the European Center for Women and Technology which – with the backing of the EU and the UN – tries to build stronger ties also with the large multinational corporations to measurably integrate more gender equality into the IT processes. One tangible result is the *"Code of Best Practices for Women and ICT"* (ECWT 2011a) which has already been signed by many large European IT companies.

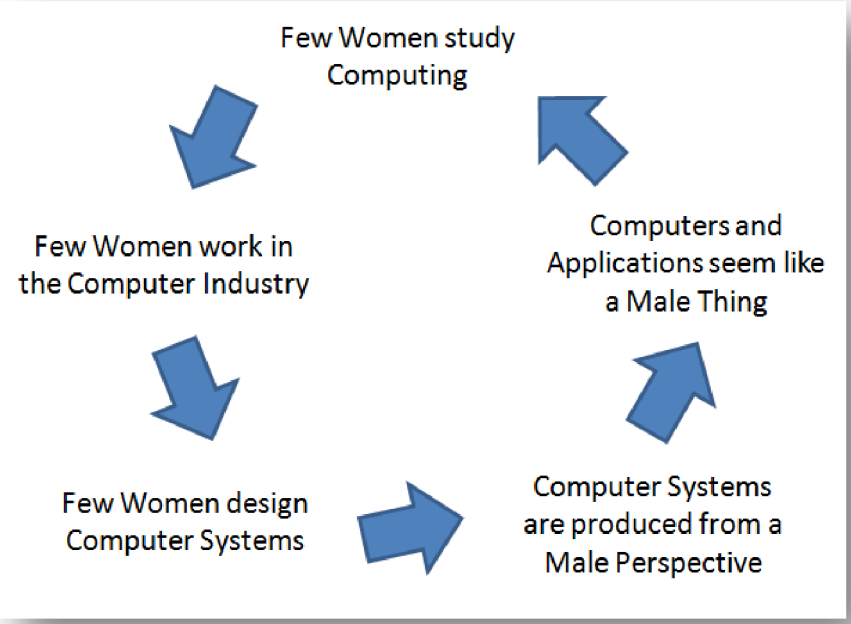


Figure 22: *The Vicious Circle of Imbalance in IT Education and Design*
Source: Further adapted from Peiris et al. (2000)

I conclude this chapter with Hynes et al. (2006, 41) voicing their hope and optimism that with IT becoming an ever increasing part of everyday life *"the stereotypical connection between technology and masculinity will focus less on male users and female non-users but will focus more accurately on the kinds of uses there are"* – which leads us to the next chapter and a closer look at gender awareness in software design.

4. Towards Gender Awareness in Software Design

"In designing tools we are designing ways of being."

Terry Winograd and Fernando Flores (1986, xi)

As pointed out by Vendramin et al. (2001, 80) *"research examining gendered designs of software or applications is scarce"* (see also Bratteteig 2002). There are very few exceptions, e.g. in the area of computer games and educational software analyzing the individual preferences of boys and girls, and a handful of studies on the usability of websites with regard to different user groups, like the example of the Digital City of Amsterdam (see Rommes 2003; Rommes et al. 2001; see also chapter 3.1.2.4). My investigations in the area of gender and business software design yielded only minimal results. Given the fact that business software applications today directly impact nearly every workplace in one way or another I feel it is important to look at the question of gender awareness in this specific area.

Therefore, after exploring the gendered nature of technology, and specifically IT, and the issues that hinder women from getting engaged and from participating more actively in the creation of technology in the last chapter, I will now take a closer look at the characteristics of business software design. I deliberately decided to keep my focus on the organizational part and will not go into details of user integration methods like e.g. participatory design. Looking at improvements in the corporate design environment to me is the more important aspect as a gender-aware organization will also naturally lead to a better integration of the user perspective and needs. Thus, in the following paragraphs I will discuss and elaborate on issues and potential organizational approaches to mitigate the phenomenon of gender blindness in the creation of business software applications and to foster gender awareness by means of an increased involvement of the 'female perspective' in the design process.

4.1 Gendered by Design?

"Software design means making abstract models […] that relate to activities in the real world […] and is about finding ways to identify and formally describe the relevant aspects so that the desired routines are automated " (Bratteteig 2002, 103). A computer scientist herself, Bratteteig concludes that even if the internal logic of computing might be gender neutral the design process – the act of choosing what is relevant to describe and in which way to represent it – expresses the particular understanding of the world held by the designer (see also Tellioğlu 2001; 2002b). He or she is *"inscribing knowledge and activities into new material forms"* (Suchman 2002, 100). And here, gender comes to play an important role as it significantly influences how we envisage the world.

4.1.1 **A Balance of Perspectives**

Building on the insight that software design is a materialization of knowledge, Sefyrin (2010a, 3) underlines why it is so important to closely pay attention to who is involved in these processes as well as to a balance of perspectives (see also Maass et al. 2007, 22; Winograd/Flores 1986, 77):

> *"IT design starts in visions and dreams about something different and better than the existing […] based on particular understandings. This realization opens up for questions about what kind of an understanding this dreaming is based on, who sees a problem, and for whom it is a problem. The issue of what is 'better' than this particular understanding of reality is not self-evident; the question is who it is better for, from what perspective, and in what sense. Since IT design has far reaching consequences for […) individuals, it is important to ask who is involved […] who are trusted with this responsibility, and who are accountable for the consequences."*

With my focus in this thesis being on gender I see it of paramount importance that both men and women, different worldviews and backgrounds, inform the design of software and all perspectives are being equally integrated. As pointed out earlier, 'gender-blind' design processes like the I-Methodology or gender scripts (see Rommes et al. 2001; Akrich 1995) tend to reinforce a gendered culture which is again a basis for designing new gendered technologies with all the negative consequences for underrepresented user groups and society at large as described in the last chapters. Software design going "*hand in hand with the design of use practices"* (Sefyrin 2010a, 2) and by this influencing an es-

sential portion of the daily life of users in supporting some activities and preventing others, I would like to once again pick up Wajcman's (2009, 150f) plea who underlines the importance of integrating the female perspective into the design process of digital artifacts by stating:

> *"While it is not always possible to specify in advance the characteristics of [...] information systems that would guarantee more inclusiveness, it is imperative that women are involved throughout the processes and practices of technological innovation.[...] Drawing more women into the design [...] is also crucially about how the world we live in is shaped, and for whom."*

In the light of the discussion around involving more women into software design I agree with Bratteteig (2002) when she stresses that this does not mean female engineers do necessarily create different software than their male colleagues, although this may be the case. But it may also be the case that gender is being overruled by professional culture. It also does not mean female designers necessarily always focus more on the needs of female users as illustrated in the DDS example (see chapter 3.1.2.4; also Webster 1996, 172). Yet, Faulkner (2001) argues that even though there is little empirical evidence of different styles brought to engineering by women and men, women – due to their socialization – are nevertheless more likely to bring a caring ethic to technological development. Although this is a rather essentialist argument, she asks why it should not be possible that due to the 'significance of situatedness' (see Haraway 1988) women are better prepared to see and sense the needs of female users. This argument could be enhanced by previous (and again rather essentialist) findings around women's generally different, more solution and user oriented approaches to design and their greater consciousness of social contexts and interpersonal skills looking more at the application-focus and usefulness of computer systems than *"becoming enthralled by the technical and abstract qualities of them"* (Webster 1996, 160ff). Cindio/Simone (1993, 191) add to these considerations by summarizing empirical observations from their work which show that women are in general better prepared to understand *"the true functioning of organizations"* based on their willingness to cooperate with colleagues and respect other individuals' competences. From a technical perspective, Bratteteig/Verne (1997) point to studies indicating that female software engineers have different preferences than men, e.g. in the context of graphical design, user interfaces or testing, due to a different spatial perception (for a study on female preferences with regard to user interfaces see also Leventhal et al. 1996).

Woodfield (2000, 41) reports that many companies – pressured by the current economic developments and organizational challenges – over the last couple of years have tried to correct the mistakes of earlier staffing

> *"[…] with the suggestion that a large infusion of the 'female factor' may be the best prescription for correcting these flaws […] Women and their 'feminine' traits should be re-imported into the changing landscape of development work […] to produce the skills profile of the optimal worker within occupational computing."*

4.1.2 **Masculinity in the Design Process**

The software design process is not only influenced by the individual designers and the many factors that impact an individual's perspective but also by the overall design group, group processes and even factors like external agendas, goals, timelines, resource limits etc. Gendering takes place at many levels and stages in the processes, and in summary, I concur with Bratteteig (2002, 99) in her assessment that gender influences the work processes in software design because

> *"[…] designers have gender, their experience in life has gender aspects to it, and they act as part of a gendered society."*

Most application software research, design and development is organized in discrete projects and often large and spatially distributed teams which – if unchallenged – reflect and strengthen the links between prevailing masculinity and technology design (Murray 1993, 72ff). Usually, the key success criteria are to build the product according to the specifications and to meet the planned time and budget limitations. A specific user focus or sensitivity with regard to a gender-aware organizational set up is often not considered. The common project culture and mentality in the business software industry require project managers and team members to *"work odd and often long hours and to possess demonstrable competence in the discourse and techniques of milestones, deliverables, and objectives"* (ibid.). The constant pressure on the project teams is often glorified and the evenings and weekends in the office are seen as inevitable and heroic, masculine activities. As pointed out in chapter 3.2.3.2, proclaiming this culture means that those women who have childcare or other domestic responsibilities cannot equally participate in such software design and development teams having to leave the ground to their male colleagues. And in the rare cases where managers try to respect the family situation of

female designers not forcing them into longer working hours, these women usually still feel bad about the situation as Murray (1993, 74) shows by citing a female software engineer:

> *"The fact that some people can live up to the expectations of long hours is nevertheless threatening to those who can't. […] I still felt almost guilty going home when the others stayed, particularly because almost everyone else was in a position to do so, which was stressful."*

As a result, software design and development teams are dominated by male IT professionals and the processes are still largely reflecting the overall masculine notion of technology. Women are mainly to be found in training, documentation or support functions and are underrepresented in project management interacting with other IT professionals and managers (Vendramin et al. 2001, 85f). In order to create a gender-aware perspective, software companies would benefit from actively implementing 'gendered lenses' and allowing different sets of experiences and ways of thinking in the design teams and in interactions with their various user groups as a basis for a broader set of ideas and visions of future products and to get different evaluation criteria for what makes a system successful. As Pain et al. (1993, 27) put it:

> *"Bridges of understanding and respect have to be built between the different interest groups – the technologists and users, the workers and managers. All parties need to be recognized as having a legitimate position and be regarded as 'experts' in their own area."*

4.2 Building a Gender Aware Organization

An IT employer can take a couple of approaches towards the creation of an organizational and working culture that fosters the usage of the female innovation potential in software design. The first and most important steps are the understanding and acceptance of the masculine notion in IT and software development and a willingness to analyze and change existing power structures and relations.

4.2.1 **Management Commitment and Culture**

Any lasting changes in structures and mindset in a corporation need to be initiated and – more importantly – continuously 'lived' by top management (see e.g. Schein 2010, 22). It is therefore of paramount importance that the board and the top executives 'walk the talk' and become role models themselves. There needs to be a tangible and visible commitment to the employees that the company recognizes the importance of gender diversity and is taking a structured approach to readjusting its recruitment, career, training, team development and software design processes in a gender-sensitive manner avoiding the trap of forcing women to adapt to the existing male environment. Rehm-Berbenni (2011) coined an expression which I find is a useful motto to describe the organizational objective: *"United without confusion and distinct without separation"*. Activities supporting such a gender aware culture in the organization could comprise:

- implementing specific gender programs and workshops which are mandatory for all people managers, including gender coaches as well as female role models who continuously transport the ideas and messages
- setting targets for a percentage of women in middle and senior management positions including the board and supervisory board as well as in professional or expert roles in the design teams
- establishing key performance indicators (KPI) to measure all managers against these targets and motivate them to actively develop and promote female employees
- creating transparent hiring processes and a dedicated, gender sensitive talent and career development program
- initiating a specific mentoring program for female top-talents with mentors from senior management, and later also for men with female top managers as mentors
- offering opportunities and defining dedicated spaces and platforms for women to become visible and present their ideas without having to adapt to existing male networks or habits

- tackling the issues of workload and working times by implementing adequate objectives and respective project management capacities to allow women to equally participate in software design and development projects

- compensating for the usual peaks in working time by offering flexible working hours and home office solutions as well as childcare-facilities, like e.g. parent-and-child offices for all employees.

One example of a step in the right direction with regard to gender KPI has recently been announced by SAP, the market leader in enterprise application software. The company plans to increase the percentage of women in managerial positions from currently 18% to 25% in 2017 (see ECWT 2011c). SAP wants to achieve this primarily by changing its hiring policy, giving preference to a greater gender balance in the case of equally qualified applicants. There will also be increased support and incentives to prevent women already working for SAP from leaving in the shape of improved working conditions like flexible hours, parent-and-child offices and a crèche on the premises. Although 25% does not sound much at first, it is yet a reasonable percentage given the current lack of qualified female applicants in the IT industry. I am confident that once this threshold has been reached many processes and the overall organizational culture will have changed in a way that will encourage more and more women to (re)consider a career in the software business, e.g. encouraged through a larger amount of visible female role models.

4.2.2 **Gender Workshops and Team Development**

The first step towards any change being awareness it is crucial that the managers, employees, and specifically the design teams, get educated by skilled professionals about the importance of understanding and valuing gender differences and individual views and contributions as assets to broaden the design perspective towards more diverse and user-friendly solutions. The objective needs to be a common understanding of the significance of ‘gendered lenses’ in the software design process. Specific aspects of these workshops or trainings could cover:

- insights into the gendered nature and history of technology and the implications for women as creators and users of software which exist still today

- a reference to the apparent lack and marginalization of female contributions and skills to IT design
- the uncovering of social closure strategies based on a masculine definition of professional competence and expertise which keep women from equal participation
- an overview of different learning styles, different preferences with regard to the interfaces and usage of applications, and different approaches to technology design
- sparking appreciation for the valuable contributions created by gender diverse teams with different backgrounds, perspectives and roles
- raising awareness about common, implicit gendered patterns in the own behavior as well as about prejudices vis-à-vis 'uncommon' behavior from male/female colleagues
- explanations of the different operational styles and approaches men and women might take with regard to communication, voicing (or not voicing) opinions, and managing teams
- raising awareness about the problems of essentialism and stereotypes and the ambiguous nature of skills and competences, specific behaviors and traits which cannot be ascribed to all men or women but vary within the gender groups (see e.g. Kleinn/Schintzel 2002; Adam et al. 2001; Webster 1996, 163)
- alerting the participants to the pitfalls of implicit gendered design methodologies and the necessity of obtaining intimate knowledge of the users' situation and needs with a specific focus on gender differences.

Overall, IT professionals need to be aware of their responsibilities to actively brake up dichotomies and dualistic stereotypes with regard to male and female strengths, both in the context of the creation and use of software (Winker 2002, 77). While individuals cannot achieve major changes on their own, it is important to make them understand that they can yet check their specific activities and rethink them with regard to gendered perspectives and stereotypes thus helping to detect and avoid content-related constrictions in the design process. Looking at the structure of the design teams, a professional team devel-

opment approach can help to analyze the different strengths of the team members and control the dynamics within the group in order to make the overall team successful. A key success factor is the right balance between gender diversity and different roles based on separate *"clusters of behavior"* (see e.g. Belbin Associates 2010). Besides the individual strengths, the team also needs to be aware that each of these roles comes with some weaknesses which also form part of the overall personality.

As an example, I would like to again quote the case of SAP. The company understood that it cannot afford to miss any of its female talent. In order to create awareness of women's and men's different styles of thinking and communication and turn equal opportunities for women into reality it started the '*Women and Men@SAP'* initiative in 1995 (see figure 23). The objectives of this program are to establish a cooperative working environment in which all employees enjoy appropriate development opportunities and support measures that promote an improved mutual, gender-specific understanding and thus help increase SAP's efficiency and innovativeness. Dedicated actions and offerings include career and work-life balance advice, coaching, mentoring, and supervision, and specific gender awareness workshops for men and women.

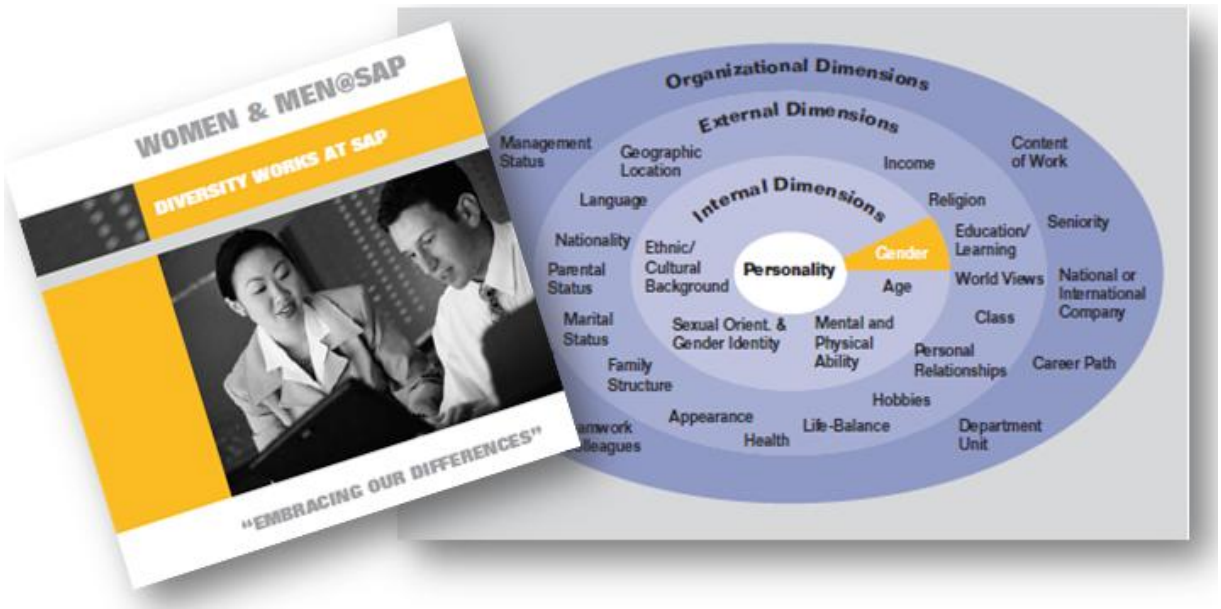


Figure 23: *'Women & Men' Initiative at SAP*
Source: Internal SAP Employee Communication

4.3 Implementing a Gender Aware Design Framework

Having created a culture of openness to gender diversity and an organization of gender-aware design teams as suggested in the last paragraphs, the next step needs to be an active implementation of a gender sensitive design framework. The theoretical knowledge provided in the gender workshops should be translated into practical action analyzing and recreating the current settings and procedures, and identifying any gendered design processes and 'scripts' in the organization.

4.3.1 **'As-Is' Analysis**

A potential approach of analyzing the status of the design framework could be based on the concept of Rommes et al. (2001) who distinguish between the structural, symbolic and identity level of software design, as outlined and enhanced with some exemplary question below:

- *Structural – Assessment of any gendered, stereotypical division of tasks in the design teams*: How many women are participating? Who is taking the decisions? Are all opinions equally valued? Who has or claims to have the technical competence? Who creates the applications? Who carries out the supporting tasks?

- *Symbolic – Assessment of the notion and values represented in the software*: Are individual interests or social beliefs of the designers built into the applications that conflict with the interests and needs of the users, e.g. is the software rather designed for its own sake prioritizing values of virtuosity than being practical for daily use? Are stereotypes and dichotomies (unconsciously) embedded into the software? Is there a gendered use of symbols and language?

- *Identity – Assessment of the projected user identities*: How do the designers assess the attitudes, interests and learning styles of their users with regard to the software they design? Do they implicitly project their identities onto their users, e.g. let 'technology fascination' and 'learning by trial and error' dominate the usability aspects?

4.3.2 **New Setting**

Based on the findings of this analysis, the team structures and roles, design methodologies and user integration methods will most likely have to be (partially) changed and restructured. Following some examples for action:

- In order to better address and include female users and counter stereotypes more female designers should be involved and empowered in decision making positions in the design process (see also Rommes/Faulkner 2003, 4).

- The design teams need to look for ways to get engaged and actively integrate users in the design process aiming at *"deconstructing the use-design opposition"* (Crutzen/Kotkamp 2006, 1). Understanding user know-how and usability issues in the context of use also opens up potential new areas of application, e.g. in the private sphere, life-long learning etc. (Winker 2002).

- Seemingly gender-neutral design criteria like 'quality' or 'good use case' have to be deconstructed to show any implicit gender connotations and reconstructed in a gender aware manner (Rommes 2003).

- When using the I-Methodology it should be *used "in a reflective way that examines differences in the experience and situation of designers and their target audiences"* (Rommes/Faulkner 2003, 5). While being considered a rather gender biased method when being applied by male designers it can – under specific conditions – also help to correct the perspective of what potential users might want if being applied by a woman (Rommes 2003, 6).

- Specific emphasis should be put on the UI design which is a key lever to improve user friendliness and to also reach more female user groups (see e.g. Peiris et al. 2000).

- A dedicated *"gender guide"* – a code of practice for software and UI design – as proposed by Bührer/Schraudner (2006, 13 ff) could be a good means by which to systematically check and integrate gender aspects into the projects and make sure relevant questions are being asked along the way.

An important challenge in this context is to make sure gender aspects are detected and perceived as relevant without essentializing them – otherwise companies risk to either reinforce stereotypes or force women (and those who do not fit the norm incorporated in the technology) *"to change, educate themselves or stay out"* (Maass et al. 2007, 23). Overall, following the post-structuralist approach, the design framework needs to allow the designers to freely study the different particular applications and to use contexts rather than designing from their own perspectives or basing their work on stereotypical users and situations.

Before moving on to the practical validation, I would like to sum up chapter four with a statement from Maass et al. (2007, 22) listing the different aspects and perspectives that need to be taken into account when aiming for a more gender aware and inclusive approach to software design:

> *"A combination of insights into gender issues on a theoretical level (e.g. gender-specific division of labor, gender connotated values and skills, and gender identity concepts), detailed studies of users and use contexts as well as direct involvement of users in the design (participatory design) will help designers in the construction phases to make decisions that explicitly take up and shape social reality, including gender relations. Such decisions may lead to Information Society Technology that supports and empowers a diversity of users."*

5. Reality Check: Gender and the Software Industry

"I was immediately thrown in at the deep end."

An Interviewee

In this chapter, I introduce four case studies of female IT professionals working in the global business software industry. A special focus was on the question if any of the gender issues explored in the theoretical portion of this thesis are reflected in the personal 'technology history' of these women and whether and how gender plays a role in the organizational processes and teams steering the design of business software applications.

5.1 Interview Framework

The interviews for the case studies were conducted as 'narrative reflections' (see Atteslander 2010, 143; Flick 2010, 227 ff). The participants were provided with a set of optional guiding questions upfront which served to prompt memories about situations and feelings (see Appendix). Overall, the interviewees were free to ponder into the directions which seemed important to them to contribute to the subject. I asked further questions were necessary. On average, the interviews lasted about 90 minutes. The recordings are stored on digital audio files and are available to reproduce the exact wording if necessary.

5.2 Profiles / Case Studies

All four interviewees have experienced various professional stages, companies and team situations along their careers. Coming from different educational backgrounds they reflected on their experiences in the context of gender and technology and software design starting from their childhood and families throughout education and professional development and the situation in their various teams closing with personal recommendations on how to increase gender awareness in IT companies. In order to protect their privacy, I am using pseudonyms for the case studies which I briefly summarize in the following paragraphs.

5.2.1 **Anja, 26 Years - User Interface Designer**

"I am a workaholic."

Anja has a diploma in informatics / digital media. In school, she dislikes natural sciences like chemistry, physics or biology, but she is good at mathematics. Her idea of informatics is affected by the 'computer nerd' stereotype, and she does not see any practical value or potential for an IT profession. She rather likes all kinds of creative work in the context of advertising, media or TV. A side job in an advertising department of a book chain gets her closer to the possibilities of computer design and the internet; she learns to work with creative design software and decides that this is interesting and fun. A friend who had already studied several semesters of 'digital media' at that time fully convinces her of this direction by describing the many fascinating projects students do, like e.g. shooting short movies or creating TV ads. Anja starts to study digital media – as one of about five women in a group of 50 men. Although being aware that informatics is also part of the subject, she is nevertheless surprised by the amount of IT topics like architecture and programming languages on the schedule, which she still dislikes and does not see a practical value for. Yet, due to her 'female assiduity' ("*Women are more hard-working than men – even if the subject is not fun"*) she constantly has better marks than her male colleagues but is always looking for a way to combine creativity with useful purposes and user value – which she finally finds during the advanced study period in the subject of 'human computer interaction'. Overall, Anja feels that at school and university she never experienced any kind of open or indirect discrimination. In contrast, she felt well treated and having even an advantage as one of very few women. The professors openly welcomed female students. Unfortunately, there was only one female professor, so no real role models or female mentors were available.

Already as a student, Anja spends a practical semester at an international business software company where – due to her excellent performance – she can continue to stay through her diploma thesis and finally continue as an employee, first in development and later in the research department. Working as a UI designer, she immediately gets into the classical type of '24/7' software project experience with a virtual, international team setting, communication across various time zones, late-night meetings, direct customer contact and the pressure of deadlines. Despite this ambitious setting and the high degree of responsibility delegated to her early on, Anja feels very motivated both by the level of

support she gets from her direct managers and colleagues, especially from an experienced female team member, and by the freedom and flexibility which is granted to her with regard to working times – provided the targets are met. She appreciates the challenge and the excitement and, as a single, has no issues with working long hours and being contacted by the project team also during her vacation to help out with customer requests *("I am a workaholic"*). She compares herself to her mother whom she cannot remember doing nothing even for ten minutes. In her current position, although again being one of only very few women in her department, she feels treated equally and able to fully bring in her skills and expertise. Apart from one recent negative experience, she is also very satisfied with the career support she has received from her managers so far. She remembers few occasions where senior customer representatives tended to ignore her as a young woman in the beginning of project meetings, but who had changed this behavior when recognizing her professional competence. Anja is convinced she has managed to keep her own style and personality and never had to adapt to any other patterns in order to be successful in her profession. She characterizes herself as a 'networking person' and *"the one who motivates others to go for a beer in the evening after a long day on the project".* She stresses the importance of the mentors she has chosen early on in her career for her personal and professional development. Overall, she concludes that she feels very comfortable as the 'female exception' in a male dominated IT environment.

Asked for recommendations she would give to software companies to increase gender awareness and support for women, Anja suggests that companies should make sure to always and only promote employees based on their skills and not because of any quota. She underlines that women in management positions who lack the necessary skills have negative implications on all other women as they are closely watched, so skills, education and training and the right choice of managers are important criteria for a positive perception of women in senior positions. With regard to the user focus she recommends to increase the amount of time designers can spend at the customer site and the user-interaction cycles planned in the projects in order to raise the awareness for the needs and reality of the users as a basis for a user and gender aware software design.

5.2.2 **Christa, 45 Years – Software Product Owner**

"I did not want to study with the nerds."

Christa has a diploma in business economics and is living with a partner. She comes from a family of "craftsmen and teachers" and as a child behaves and feels rather like a boy. Her grandfather shows her early on how to deal with any kind of technology, and she is able to fix many things alone, for example her bicycle. Christa has always been good at mathematics and physics which she ascribes in part to a very good teacher who was able to explain the interrelations and bigger picture of the subjects. As one of about five girls in a class of 30 boys she nevertheless feels fully integrated *("I did profit from the emancipatory movement of that time"*) but lacks role models as there were no female teachers in the natural sciences. She is taught informatics at school but deems it a strange and uninteresting subject with a strong focus on hardware and cannot imagine any value for a future profession – a notion which fails to be corrected by the student advisors either. Christa at that time completely lacks practical examples in the IT context and cannot imagine spending time at university with the 'nerds' she already dislikes in class. Being told at home that a higher education needs to lead to a profession that allows earning a living she finally decides to study business economy which is said to be a good basis for a broad choice of industries and professions. In order to pursue at least parts of the subjects she likes she chooses physics as an additional course but experiences it as very "*dry and formal – pure methodology - without any tangible examples"*. In economics, she focuses on quantitative subjects like operations research and finally chooses energy management which allows her *"to combine math with methodology and meaningfulness"*. Again, she is one of very few women but does not recognize any disadvantages due to her gender. Christa who herself is active as a cyber-mentor for young girls is convinced that the stereotype of women being bad at mathematics is a social construction and has no scientific basis, but nevertheless serves as a kind of self-fulfilling prophecy as this image influences the opinion and self-consciousness of girls early on.

Already during her diploma she starts as a working student at a regional energy provider and has her first encounters with computers. As the only woman and with a background in economy in a team of "*typical engineers"* she feels completely overlooked and marginalized while all interesting jobs are given to the male students *("My boss did not even know my name (…) he could not deal with female employees"*). Due to this situation, she later

rejects a job offer from this company and continues with an additional year of studies in Italy. Back in Germany, Christa starts with a young and prospering business software company as an energy consultant. Again, she is the only women apart from some female colleagues in the accounting department. *"I was immediately thrown in at the deep end"*, she remembers. She enters the classical IT project set up where the consultant has one of the hardest jobs traveling and being at the customer site six days a week. The project managers are very tough and demanding and show no respect or understanding for personal needs. Christa is even spending her birthday on the road. She describes the company culture as extremely competitive; everybody wants to be the best and the first fighting the colleagues wherever possible. Her project managers don't provide any feedback apart from *"that's shit"* and have no problems attacking her unfairly when it serves their purposes. It is normal that the team does all the work and the project manager presents the results without giving any credit to his co-workers. After one and a half years she has lost all her motivation and posts a job advertisement herself.

She gets many proposals and decides to move to a smaller software company doing customer support and consulting. Her new manager is the opposite of what she experienced so far. He treats his employees emphatically and fairly, and plans and runs his projects without burning his staff. In her team, there is an equal percentage of men and women. Shortly after, this company gets bought by a larger multinational software company and her boss gets demoted. In this context, Christa speculates that "*the good and empathic male and female managers who are able to install an open and positive feedback culture are maybe not hard enough to withstand the political fighting"*. In the new company, she accepts an offer to change into a comprehensive new position combining product management, development, project management and customer training. For a couple of years, she feels well integrated, *"although it were again always the men who got the really interesting jobs"*. She likes the flat hierarchies and the daily challenges despite the heavy workload that leaves no time for anything else. With an increase in hierarchical levels, Christa recognizes how difficult it is for a woman to make a career in IT. She is surprised at the amount of unqualified male managers ("*That was the time I still thought it is performance that gets you to the next level"*). Her advancement is finally due to a very supportive female manager and her own proactive approach to present a project proposal and claim a manager's position. Yet, she is aware that this might have been one of the largest career steps in her life with the next level being extremely hard to reach.

As a best practice, she recommends managers to always take enough time, listen to their employees and provide active feedback – both positive and negative – in order to support their personal and professional development. She does not want people to feel like having to be available around the clock but make sure the team members can manage their work-life-balance. In addition, she underlines the importance of also providing challenging tasks for men and women working part time. Christa's recommendations for an increase in gender awareness cover dedicated, mandatory gender workshops, especially for men, and a new way of formulating job descriptions by means of eliminating abstract, methodical statements in favor of practical descriptions of the tasks to be done. In addition, the stresses the necessity to run objective competency analyses to avoid men only being promoted because they belong to the 'Old Boy's Club'. From her perspective, many managers are still in the wrong positions due to a lack of objectivity in this process. She argues for a talent management and team development process that specifically and methodically looks at the different skills and contributions as well as at the development needs of women and men in order to get to a more balanced and productive team staffing. In her opinion, this will lead in many cases to the awareness that women are key driving forces in the projects.

5.2.3 **Maria, 46 Years - Design Consultant and Trainer**

"Women in Germany often take the 'Baby Exit'."

Maria is married and has diplomas in biology and computer science and a Ph.D. in behavioral ecology. She comes from a family with three girls where the father actively made up for his lack of formal education by teaching himself and telling the girls to use their intelligence to *"do something with it"* supporting them all along their educational paths. Maria ascribes her fascination with natural sciences to an early family discussion about the existence of god. Ever since she has wanted to figure out how nature works. In school she is always good at mathematics (*"I had a very supportive math teacher"*) and biology, yet hates physics. With a teacher's job in mind she studies biology and uses the free periods for work and travel. When the first chair of computer sciences is founded at her university, Maria – always eager to learn something new – immediately takes informatics as a secondary subject and starts as one of the first students on this course. She likes to explore computers and narrates how she bought one of the first Atari's without basically knowing

what to do with it, but to figure out what it could be good for. When being offered a contract as a student assistant informatics lecturer from her university she agrees and immediately starts to teach while in parallel learning everything necessary and doing programming herself. Apart from her, no other woman gets engaged in the subject as it is *"too difficult"*. Still being very active and interested in biology, she then accepts the offer of her main professor, *"who was very supportive"* to join him on research trips to Jamaica becoming even his deputy at university later on. Again, she is the only women in the research team but gets treated with much respect, yet, she also recognizes that she has to continuously prove her competency in order to maintain that respect. Personally, she characterizes herself as a very strong and determined personality who also *"supported and pushed both partners in my life to finish their own studies successfully"*.

As a post-doc, the normal life at university turns out to be quite unpleasant and makes her look for another opportunity. "*The hostile atmosphere, the unfair treatment by my male colleagues, and the ongoing fighting and competition brought me to finally even leave into unemployment".* Maria enrolls in a technical writing class to broaden her qualifications and later starts as a technical writer with an equipment company she knows from her biology network. Still interested in and knowledgeable about computers and informatics, she then switches to a small software company and from there to a global one working as a solution manager and later on as a design consultant and trainer. In her last teams, there was always an equal percentage of women, yet she noticed different behavioral patterns of her male colleagues ranging from a *"pub mentality"* making jokes behind women's backs to managers that cannot really deal with women's reactions, e.g. when becoming emotional during a discussion. She refers to one female manager as an exceptional example – a good role model showing on the one hand a high level of emotional intelligence, but on the other hand also a "*fighting mentality"* if necessary ("*she was a wonderful supporter*"). Overall, Maria does not feel that women have tangible disadvantages in this setting, nevertheless, she concludes that almost all leadership positions are held by men and that the few female managers (apart from the positive example cited above) often aggressively pursue their career – a behavior which she thinks lets most capable women shy away from management positions as they dislike the competitive environment and the fights that are necessary to succeed. She also notices that women in Germany often take the "*baby exit"* when things start getting difficult and unpleasant for them, and that the national culture in the country positively supports this move. Looking at her experiences as an internal

coach she finds it interesting that women rather look for coaching in personal change processes while most men seek a dedicated career consulting.

From her perspective as a design consultant, Maria stresses the need for gender diversity in teams and believes in a multi-disciplinary and multi-gender approach to software design in order to create customer friendly and gender aware solutions. When teaching design thinking, she always makes sure to have at least one woman per team. She would recommend software companies to systematically create the awareness for gender issues and inequalities within their employee base using strong examples to show the degree to which women are neglected in order to make the case. She describes how the participation in a gender workshop opened her eyes and also grew her internal network. In addition, she underlines the importance of a project management culture that allows both men and women to have a good work-life-balance as a basis for productive teams. Finally, she has a special recommendation for women who are of small size to make sure they are not overlooked: "*I learnt early on that with only 1,60 meters of height, I always had to be the loudest to get heard".*

5.2.4 **Barbara, 47 Years - User Experience Designer**

"I don't rely on anybody."

Barbara, married with one daughter, has a diploma in computer science from a former Eastern German university. She grows up in a socialist system where women are being seen and treated as equally capable, e.g. with regard to working times and conditions or in the context of education. There are similar numbers of boys and girls even in technical courses. Social support systems like nursery schools allow all women to fully participate in the professional life – a bare necessity as a divorce rate of about 52% requires many women to be financially autonomous. Barbara's motto is thus shaped by her mother's early advice: "*Don't rely on anybody – if you want something, you need to be able to achieve it by yourself!"* Always good at mathematics and physics and inspired by a wealth of strong female role models ("*There were generations of female mathematicians and engineers in Eastern Germany"*) but without any technical background or prior experience she follows the recommendation of her sister and studies computer science which she deems a new and exciting subject with potential for the future.

After her studies and the German reunion Barbara moves to Western Germany and works in the IT department of a large company – as one of five women out of 150 employees. She immediately recognizes that in this part of the country women in IT are not treated equally. *"I felt discriminated, both as a women and coming from Eastern Germany"*. Although having a supportive manager and a good working relationship with her internal customers she feels in constant competition with her male team colleagues who talk behind her back and generally behave in a hostile way. Moving to a large bank as an IT consultant she observes a shift in mindset with younger people being more open towards multi-gender teams. The following job change to a US consultancy provides her with insights into professionally managed gender programs and a generation of *"tough Californian girls who are willing to work hard for their careers, but without giving up their personality and family life"*. She contrasts this to the German system where women are mainly undecided whether or not to focus on their professional careers and financial independence, and where the tax system encourages them to stay at home (*"If women in Germany are married and have a job, they usually only work for being able to pay for the childcare"*). Coming back from the US, Barbara joins a large software company as a UI designer. When thinking of her organizational experiences as a female team member her overwhelming impression is that men until today still fight for their careers with any means and feel offended and threatened by successful and competent women. For her the 'glass ceiling' is a reality, and she is convinced that the men in the *"Old Boys' Networks"* will try to keep their positions as long as possible if not forced to change recruiting and promotion processes. She experiences many cases of direct discrimination and marginalization where male colleagues and managers build on her input to position themselves, and to her surprise, HR departments – often a domain of women – have not turned out to be proactive for or supportive of female employees. Overall, Barbara characterizes herself as a *"pioneer character"* who likes challenges and disruptions and is motivated by kicking off projects and getting them in the right direction. Amongst others she has been instrumental in setting up and driving a corporate women's network and a mentoring program. From her experience, women who succeed in an IT career *"have a price tag"* – they often don't have many social and personal relationships outside work, no families and kids and have given up on their 'feminine part' adapting to the male culture. After playing the 'boys' game' for a while she has seen many of them becoming frustrated with the amount of personality change and sacrifices necessary to succeed.

Asked for recommendations Barbara stresses the importance of networks and trusted mentors to help women keep up and succeed in the IT environment. She explicitly points to the necessity of successful women leaders taking care and supporting other women in order to increase the level of diversity and gender awareness in the software industry. Her advice for any woman is to remain authentic and sure about herself without changing her style, behavior or personality. Her credo: "*Successful women play to the rules until they have got enough recognition and 'standing' so that they can break them to their own and other women's advantage".*

5.3 Interview Results

In the following section, I summarize and structure the key points from the case studies starting with the experiences the four women made in the context of their educational and professional development as well as in their current roles, followed by suggestions they made with regard to improving gender awareness in the software industry from an organizational perspective and finally recommendations given to other women in IT.

5.3.1 **Educational and Professional Development**

All of the four interviewees were one of only very few women in their classes, university courses and finally their professional surrounding which reflects the general situation of female participation in IT education and the software industry. All of them can be characterized as very strong, goal-oriented, 'mobile' and independent women actively shaping their careers supported and motivated by their families. Three women specifically report being told to strive for higher education and financial autonomy by their parents. Each has a special strengths in mathematics and in additional technical and scientific subjects and – apart from regretting the absence of any female role model or mentor in the technological and IT area – none complained about the didactics with one exception: The educational systems obviously lacks (or lacked at the time) the ability to transport the practical relevance of an IT education for a future career and to eliminate the 'nerd stereotype' which kept the majority from considering IT in the first place. The one woman who chose it as a first field of study did so based on the pure assumption that it is something 'new' and must have some potential for the future – rather than seeing a direct and practical usefulness.

Another commonality is the memory of at least one teacher or professor who was extremely supportive and instrumental in shaping and strengthening their positive attitude towards science and technology and providing them with the 'big picture' of the subjects. Analog to Birbaumer et al. (2006) I found that the woman with a 'straight career' in IT showed a slightly stronger focus on the technological aspects while the others who studied a different subject first rather emphasized the practical value and design aspects.

The younger woman stresses that – apart from one exception – she never felt unequally treated and appreciates the opportunities in the software industry as well as her career progress so far. Being not yet in a managerial position, she did not experience any competition with male colleagues around such jobs until today. The three women with a longer career history across different companies in unison describe several situations in their working environment that were and are marked by strong and partially unfair competition and a dominant behavior of male colleagues. All have experienced varying levels of marginalization and disadvantages with regard to promotion and career development. In all cases, the decisive and key managerial positions are being held by men who also often built their successes upon the input from their employees without giving them much credit for their work. They report having to put more effort into their work and 'do more' in order to prove their competence and secure the respect of their male colleagues and managers. Interestingly, each woman mentions a very strong and supportive female manager or colleague whom she sees as a role model. On the other hand, three interviewees also specifically refer to negative examples of female managers who showed similar patterns as their male colleagues with regard to opportunism and competitive behavior. From their experience, it seems that positive attributes like empathy and fair treatment of employees do lead neither male nor female managers into higher positions, and that it is rather the network, internal politics and the connections to the 'Old Boys' Network' than actual performance that make careers. It turned out that Eastern European and US cultures are likely to be more gender friendly and focused on equality than those in Western Europe. The tenor for Germany is that most women don't want to get engaged in the 'career fighting' and either remain in their subordinate positions or – in bad cases – finally prefer staying at home with children to having to stand the competition at work. Similarly, all four women have been confronted with the extreme time and workload requirements in the software industry which most of them complied with – and even liked it – for a long time. Yet, getting older the wish for a more appropriate work-life-balance grows.

Two of the four interviewees are active contributors to an internal women's network and are initiators of both internal (mentoring) and external (cybermentoring) educational and career development programs. One woman reports of having learnt about the benefits of an internal network after having attended a gender workshop, and the youngest woman positively reports about the relationship to the professional mentors she chose when starting with her current company (for a discussion of female networking practices in the scientific context see e.g. Haas et al. 2011).

5.3.2 **Organizational Recommendations**

The list of recommendations the interviewees would provide for companies in order to improve gender awareness in the organization and in the design processes covers:

- measures to increase gender awareness and value diverse skills and contributions across the organization like e.g. dedicated workshops which are mandatory for all managers, and especially for men
- gender aware talent management processes which focus on the right skills, education and training for all employees, and a promotion concept based on objective competences
- a fair and transparent hiring policy equally considering female applicants and a new way of formulating job and role descriptions
- an equal treatment of women with regard to career and salary development
- a proactive analysis of existing unequal power structures and 'political systems' and measures to reduce the influence of 'Old Boys' Networks' in favor of fair and transparent processes
- specific team development programs looking at the different skill sets, roles and contributions as well as on a good gender-mix in the teams
- dedicated mentoring and coaching opportunities for men and women

- establishing a culture that allows a good work-life-balance for all employees including support options for families with children
- encouraging and enabling stronger user interaction, specifically for the design teams (e.g. through dedicated engagement programs), in order to increase user friendliness
- establishing multi-disciplinary and multi-gender approaches to software design in order to create more customer friendly and gender aware solutions
- a strong focus on UI design and design trainings for employees.

5.3.3 **'From Woman to Woman'**

The tips the four women would give to their female co-workers and all women in the IT industry include:

- looking for and building up an internal and external network of peers and trusted mentors
- the necessity for successful female managers to actively support women and get engaged in coaching, mentoring etc.
- remaining authentic – not changing their personal style and behavior to adapt to the environment
- being capable and skilled to do their jobs right, and keeping and demonstrating self-confidence
- not getting engaged into the same unfair 'political games' using similar methods as their male counterparts to compete but acting in a smart, fair and upright manner
- learning to play by the rules as much as possible until they reached a certain level of success and credibility – but then making also 'bold moves' to change the rules to support women and increase awareness for gender issues

- creating a plan for their own career and marketing it openly pointing out their competences and successes without being shy to request a management position

- using their ‘feminine strengths’ to manage their teams and groups in an emphatic and progressive way including a strong focus on gender awareness internally and with regard to the users’ needs.

In summary, the software industry does not seem to be a place for ‘weak’ women. In accordance with the findings from the last chapters, the interview results show that it is still a male domain with regard to the culture of competition, the predominantly masculine management style, few women in leading positions, heavy workloads, tight deadlines and long working hours. Yet, despite quite some negative experiences in the context of marginalization and career progress, all interviewees still like working in IT. They are aware – and at least partially also proud – of being a minority of technically skilled women in a field that is usually regarded as being tough for female employees. They feel motivated by the opportunities and challenges in their daily jobs and eager to make the next steps in their careers – yet dislike the politics necessary to get there as well as the fact that it seems to be rather the ‘connections’ than the performance that account for a promotion. Specifically one woman stressed that she probably would turn down the anticipated proposal to succeed her manager due to the disadvantages such a position brings from a ‘political perspective’. Two interviewees strongly recommend improving the design awareness amongst the teams and the structured integration of users in the design processes in order to create more user and gender friendly solutions. From their perspectives, the overall situation is only likely to change towards a larger percentage of female IT professionals and greater gender awareness both within the organization and with regard to the users if most of the recommendations made above get implemented.

6. Summary and Conclusions

"Start by doing what is necessary, then do what is possible,
and suddenly you are doing the impossible."

St. Francis of Assisi

In this thesis, I have addressed several questions to better understand the apparent absence of women as creators and the ongoing negligence of female users and consumers in the technology, and specifically information technology, context and to suggest ways to increase gender awareness in software design as an area of major impact on almost everybody's professional and private life:

Firstly, I have discussed and argued why gender plays an important role for technology design becoming a key success factor for companies of all industries and sizes in the future. Secondly, I have analyzed why technology in general, and specifically IT, can be referred to as gendered and which measures have been suggested to overcome the 'women-technology-dilemma' so far. Thirdly, I have looked at issues and proposed potential approaches to achieving a greater level of gender awareness and to increasing the 'female factor' in software design focusing on the organizational aspects in corporations. And finally, I have briefly validated these findings by means of four case studies with female IT professionals in the international software industry. My attempt has been informed by feminist theories of science and technology and both my own practical experiences at SAP and those of the interviewees working in the context of research, application development, solution and interface design for business software. The focus of the case studies was on the personal 'technology history' of the individual women as well as on the integration of gender awareness in the organizational processes and teams viewed from their perspectives.

On the following pages, I briefly summarize the most important theoretical and practical findings and provide a couple of aggregate conclusions and recommendations on how the IT industry could go forward with regard to implementing 'gendered lenses' in order to better integrate women as creators and users of software. I conclude this work with an outlook on a few potential additional research aspects in this context.

6.1 Matching Theory and Practice

After a comprehensive theoretical analysis and a brief practical validation a central finding of this thesis is that the gendered, masculine shaping of technology emphasized by most feminist authors is to a large extent reality and a key reason for the relative absence of women from IT design. While there is not the one female perspective, as there is not the one category 'woman', there are nevertheless similarities and common experiences amongst female IT professionals endorsing the masculine culture in this discipline. The case studies provide evidence that the underrepresentation of women as creators and designers of software is due amongst others to the one-dimensional approach in IT education lacking a comprehensive way of presenting the tangible and practical value of the subject in a way that appeals to female students, to gender unaware organizations and systematic marginalization of female professionals in a highly competitive environment where women are still mainly excluded from management levels and careers are often based on 'political connections' rather than objective performance criteria, to working models that do not fit most women's family situation. Women who have succeeded in an IT career are still a rare exception, and those who made it to top positions are often deemed 'inglorious examples' behaving like men and often apply the same opportunistic and political methods while having sacrificed their female identity.

Most of the existing frameworks and theories for inclusion, like for example gender mainstreaming, are still based on rather deterministic and essentialist assumptions accepting technology, hardware and artifacts at face value – as neutral, following logical patterns of 'natural' development – or, on the other hand, over-emphasize the need for 'female' values in technology. I concur with Henwood (1993) that both streams are rather unlikely to effect any lasting changes in the gendered relations of technology. The findings in this thesis underline the social constructivist perspective that technological artifacts and meaning are a social construct, and so are 'masculinities' and 'femininities'. Neither technology nor gender can be taken as fixed and given but are cultural processes subject to negotiations, contestations and transformation. Simply pushing more women into IT design based on an equal opportunities argument will not automatically change the design processes for the better. Skills and preferences amongst women differ to a large extent – while some tend to dislike 'hard technology' and the association with masculinity others come with specific mathematical and technical strengths and appreciate the scientific and profes-

sional environment and the challenges coming with it. Organizations need to be aware of this ambivalence and contradictions in order to avoid simplistic approaches to solving the gender and technology issues. The case studies show that even in a small and seemingly homogeneous group of women with similar technical strengths the individuals made different experiences and have developed different approaches and ideas on how to cope with their masculine environment. The feelings and strategies range from enjoyment and appreciation being the only woman in a male environment, to serenity and contentment with the current role and position albeit being aware of certain disadvantages with regard to their male colleagues, to attempts to fight for changes and struggle through the 'glass ceiling'. From a project and design perspective gender does not seem to get much attention in the context of business software yet, neither in the team setup nor with regard to user studies. Software design projects are predominantly led by male managers and face tight restrictions with regard to budget, resources and deadlines. There also seems to be room for improvement in the area of design thinking within the teams and concerning opportunities for an enlarged designer-user interaction.

Overall, it turned out that one of the most important prerequisites for software companies to make sure the results of their technology design fit with the needs of a variety of stakeholders, including female users, is the establishment of a gender aware organizational mindset. As pointed out by Trauth/Howcroft (2006) it is important to investigate and challenge the power relations and gendered nature of the workplace in order to address the existing gender inequality in IT. The corporate culture needs to foster the usage of gender not only as a management KPI but more importantly as a 'lens' and apply it every time new applications are being planned and implemented – ideally already in the research stage to broaden the range of starting points for the development of new solutions by defining new research questions and contexts of usage. Top management commitment is a key success factor to tackle such an important cultural change, and both male and female employees need to be aware of the benefits and opportunities a diverse organization offers. Mandatory gender workshops could be a productive element to initiate such a shift in corporate mindset. They need to be supported by a portfolio of additional measures in the area of recruiting, training, talent and career development, work-life-balance etc. Managers of design and development teams need to have specific gender skills and have to be capable of developing both men, women and teams towards more user orientation and gender awareness appreciating different perspectives and values, and motivating their

teams to a high level of collaboration. Software designers have to be aware of and alert to the pitfalls of an unintentional gender bias in their work settings and to gendered design methodologies as a potential hindrance for the development of user-friendly solutions.

6.2 Options for Further Research

While the focus of this thesis is on the organizational dimension of gender awareness in software design an interesting question for further research could be to look at ways to analyze and measure the gender dimension in the usage of business software – specifically with regard to the preferences of female users. Based on these findings, a subsequent work could then deal with the gender appropriateness of current software design approaches and frameworks. An interesting aspect in this context could be to analyze whether the recent trend of 'gamification' in business software design which intends to make it more 'fun' for the users appeals differently to men and women (see Clark 2011 and figure 24 which shows a new SAP mobile sales application designed as a golf putting scenario).

Figure 24: *'Gamification' – The Future of Business Software?*
Source: Clark/Businessweek.com (2011)

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Appendix

Guiding Questions for Narrative Reflections

Biography (Family, Education, Career)

- How did you become interested in a technological subject? What fascinates you in the context of science and technology?
- Did you have specific role models in your family? Did your family support your (technical) interests and talents, and if yes, how?
- Did the teaching methods in school or university fit with your learning style?
- Did you face any kind of direct or indirect discrimination - or receive specific support - in school, university or in your professional career? How and from whom?
- Did you ever encounter skepticism concerning your skills and qualifications?
- Were there moments when you did not feel comfortable and confident or unduly challenged by male ‘specialists’?
- Did you feel you had to be better and do more than your male colleagues to get the same recognition?
- Did you feel you ever had have to change your behavior or habits (dress, leisure activities, vocabulary…) to adapt to a masculine culture to become respected in your working environment?
- Did / do you have positive role models or mentors?
- Did / do you have a network that helps and supports you?
- Does your partner support your career (sharing of domestic tasks, childcare etc.)?
- Are you able to keep a decent work-life-balance?
- Do you feel equally treated with regard to salary and career opportunities / professional development?

'Gender Sensibility' in Project / Design Team

- Looking at the men and women in the team – who has which roles (manager, supportive roles, technical experts…)?
- Who takes the decisions?
- Whose values and experiences are represented in the team?
- Are different perspectives and ideas equally accepted / valued?
- How much emphasis is being put on understanding the users and their specific needs?
- To which extent are the designers interacting with the users?

Individual Suggestions for Gender Awareness

- In general, how would you characterize women who are successful in an IT career? What attributes do they have / what do they do?
- As a consultant, what would you recommend to a software company in order to increase gender awareness and equality
    - on an organizational level
    - to increase the amount of female developers and designers
    - with regard to the design processes and to user interaction?

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