Introduction

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What role does gender play in scientific research and the development of new technologies? This question has been asked from many different angles. This book provides methodological expertise, research experiences, and empiri cal results from a very dynamic and multifaceted field, feminist science and technology studies. In each of its chapters it connects, on many levels, in sights from gender studies and science and technology studies (STS). It aims to translate and link knowledge from gender studies produced in the humani ties, social sciences, and cultural studies to gender studies in the life sciences and material sciences as well as in mathematics and engineering. But more than this, the book seeks to enhance knowledge for the reflection and practice of scientific research and technological innovation by investigating its many gendered dimensions. It aims to show how reflecting upon gender in manifold critical ways can help to overcome gender hierarchies, exclusion practices, stereotypes, and other epistemic, ethical, and political problems.

For a long time, different groups of people have had mixed relations to technological developments and scientific advancements. For some decades the simple belief in the democratic purpose and use of science and technol ogy has been also questioned by historians of science, who pointed out the entanglements of scientific controversies with political struggles (see for ex ample Schiebinger, 1993; Serres, 1995). Moreover, sociologists of science and technology discuss the fundamental contextualization of scientific endeavor in social developments including complex structures of power (see for ex ample Jasanoff, 2003; Nowotny et al., 2001). They discuss the co evolution of science and society and demand socially robust knowledge in the sense that robustness is enhanced if research is improved by social knowledge (Nowotny et al., 2001: 167). But what is social knowledge? How can we differentiate

between social beliefs of scholars entering scientific theories, technological development or empirical research designs without further thought and knowl edge that has been systematically assessed in a collectively reflected and con trolled way? What is the relevant collectivity to decide on a certain set of questions (Longino, 1990, 2002)?

These questions become especially crucial when it comes to the field of gender studies. Because our culture has been structured for such a long time by this changing but powerful set of dynamics, there is a capacious mix of be liefs and interpretation practices about gender experienced by many scientists and engineers who are not necessarily aware of its impact on their practice of science and technology. This book was written especially for those students and scholars of science and engineering who are ready to confront unreflected assumptions about women and men and who want to learn about methods and strategies to develop research and innovation serving all genders and enable them to collaborate on equal terms. For this purpose, the book covers a range of theoretical insights from the construction of gender, sex, and sexuality to ap plications of gender in practices of engineering design and scientific reasoning.

Since the last decades of the 20th century, a field of knowledge has emerged that connects the interdisciplinary knowledge from gender studies with an other interdisciplinary field of knowledge, that of social and cultural studies of science and technology. In fact, these fields have been entangled from the beginning, forcing scholars to question undergirding theories in both gender studies and STS (Roy, 2008). This field of feminist studies of science and technology has grown rapidly as a discipline that transgresses disciplines as well as the barrier between social sciences, humanities, and cultural studies on the one hand, and life sciences, engineering, and material sciences on the other. This field has shed light on the entanglements of science and technology with gendered power relations and cultural constructions of femininity and masculinity. Although it has been quite controversial how to relate the critical insights in this powerful field of knowledge with potential participation neces sary to make changes, there was strong advocacy from early on that it is worth trying (see for example Haraway, 1991, 1997).

Since this time, feminist studies of science and technology have come a long way (Wajcman, 2008, 2010). Today, it is widely acknowledged to un derstand technology and gender relations as co constructions and as part of changing developments. The image of technology has changed from assumed betterment of life to a contested space and awareness that artifacts embody power relations. At the same time, feminisms have become just as multiple and

dynamic, especially concerning the insight that gender is connected to other constructions of power such as ethnicity, religion, sexuality, disability, and class. It is in this regard that today feminist technoscience investigates "tech nological change [a]s a contingent and heterogeneous process in which tech nology and society are mutually constituted" (Wajcman, 2008: 94) with gen der being understood as a performance or social achievement, "it is the product of a moving relational process, emerging from collective and individual acts of interpretation" (97). As a consequence, "the materiality of technology affords or inhibits the doing of particular gender power relations" (98). On the other hand Wajcman proposes that "the politics of technology is integral to a more just distribution of power in gender relations" (99). We want to contribute with our book to a better understanding of this complex relationship between gender, science, and technology.

The book emerges also from a specific local project: "For Future Innova tions: Gender in Science and Technology" was the title of a lecture series we organized in the winter term 2011/12 at the Johannes Kepler University Linz (JKU), Austria. Our aim was to show how gender becomes relevant in natural sciences, engineering, and technological development. This concern evolved in the context of our interdisciplinary work environment at the JKU, where a university wide development focus in the area of women's and gender studies promotes inter and transdisciplinary research cooperations with colleagues and students from technology and natural sciences. In this network we were able to observe an increasing interest in the role gender plays in scientific research outside of social sciences and how this category can be implemented in actual research and development processes: How can gender influence the shape of technologies at all, if these are fashioned on the basis of neutral prin ciples with regard to function and design?

The experts chosen for the lecture series at the Johannes Kepler University Linz in Austria and subsequently as authors for this volume work with a trans disciplinary approach. This means that they are familiar not only with theories and empirical results from the transdisciplinary field of gender studies, but also with those of the transdisciplinary field of science and technology studies. Nevertheless, although some authors have additionally had interdisciplinary training, all have a full scale academic background in one or more specific scientific disciplines. Coming from such diverse disciplines as media studies, computer science, social sciences, philosophy, mathematics, history, and biol ogy, the authors discuss how to ask questions about gender and give examples for their application in interdisciplinary research, development, and teaching.

The topics range from the design of information and communication technolo gies, epistemologies of biology and chemistry to teaching mathematics and professional processes of engineering.

The first section analyzes gender in the design processes of new technologies. The authors inquire how new technologies can be developed to foster equal opportunities for all genders. What role does cultural imagination play in in novation processes? In addressing these issues, the contributions do not focus on one best way to guarantee the best outcome but discuss different methods. The contributions show that there is also no 'one best way' for a feminist design of new technologies   but that there *is* the possibility to take gender into account in a theoretically reflected and methodologically systematic way in order to counteract problematic gendering. Empirical findings from both analyses suggest that disregarding the category of gender does generally not lead to 'neutral' technologies but tends to reproduce gender hierarchies and stereotypes. The authors ask questions about the role of culture in technologi cal innovations and what kind of social experiences are involved in techno logical developments.

Concerning the design of technological artifacts in engineering as well as in information and communication technologies, Anne Balsamo promotes an understanding of design practices as a "process of technocultural innovation". As this process involves human beings, the gendering of the process happens by way of the participants' imagination concerning their own gender and that of others. Balsamo describes the interactive development of a multimedia de vice within the United Nations Fourth World Conference on Women in Bei jing, China in 1995 and discusses how technological innovation can foster feminist empowerment.

In her contribution Els Rommes focuses on design strategies of Informa tion and Communication Technologies (ICT) which explicitly aim to take gender into account. Drawing on gender dimensions proposed by feminist re search, she first develops a conceptual framework for the analysis of the gen deredness of ICTs. By distinguishing particular approaches of the application of gender, Rommes discusses how a feminist design could look like. Finally she explores empirical results on how 11 European companies studied in the SIGIS project (EU Strategies of Inclusion; Gender in the Information Society) actually took gender into account and elaborates the pros and cons of the most common design methodologies.

To provide a basic methodological framework for feminist design in com puter science is the objective of Corinna Bath. Based on empirical analysis of gendering processes in the development of new technologies she differentiates four main mechanisms that repeatedly lead to gendered computational arti facts. Drawing on the work of Judith Butler, Karen Barad, and Lucy Suchman, Bath develops a theoretical foundation for a "de gendering" in design pro cesses and proposes particular technology design methods for each of the four mechanisms to systematically avoid problematic ways of gendering.

Exploring the cultural history of masking and masquerade, Cecile Crut zen discusses what it means to negotiate humanity in confrontation with new capabilities for control by the developing information and communication technologies. She asks about the meaning of new opportunities of masking oneself within ICT. She describes our world as a mixed reality, of interaction between visible and invisible aspects of existence. The author concludes that understanding the "gender masquerades of past and present" can lead us to the disclosure of the masquerade of humans in robots.

The second section of the book discusses gender in epistemological founda tions of science and technology. Here, conceptual questions about how gender becomes a problem in scientific research are asked. How is gender framed as a phenomenon constituting epistemic problems to do research on? On which conceptual paths do cultural assumptions about women and men enter research on humans as well as on organic and non organic entities? How is it possible, as scholars and engineers, to analyze hidden assumptions about gender, to re flect on guiding norms and stereotypes as well as eventually redirect research questions, experiments, methodologies as well as methods of data interpreta tion? Can we invent gender differently? Can we think of gender and diversity in ways that enables scholarship and innovation efforts to lead to emancipatory and empowering effects for all genders in a democratic future?

Discovering the hidden assumptions about women and men in the organi zation theory of the brain, Rebecca Jordan Young analyzes the methodolog ical conditions and moves of experimental practices as well as the way of formulating research questions when it comes to studies of the relevance of hormones for the development of sex, gender, and sexual orientations from the 20th century to the present. She also reflects on practices of pathologiz ing non normative behavior concerning gender and sexuality in medicine, and combines her demand for better scientific practice with an argument for taking into account the social context of research.

Barbara Orland's contribution leads us into the history of science. She shows the conceptual moves in the discourse on motherhood and breast feeding in the course of the nineteenth century. The author analyzes its relations to the practices of wet nursing and the innovation of artificial baby food in chemistry and its applications in the emerging sciences of medicine and pediatrics. She also discusses the link between scientific knowledge and the fast growing market economy. She shows how the negotiation of gender is always present in the debates on what is best for whom.

In her paper, Waltraud Ernst embarks on an epistemological discussion. She asks if it makes sense to understand gender as an apparatus (reading Judith Butler with Karen Barad), generating changing diffraction patterns in life sciences as well as material sciences. She explores the potential of conceiving and studying gender as diffraction patterns rather than differences between women and men or other organic and non organic material entities. Drawing on Butler's conceptualization of gender and Barad's theory of matter, the author searches for an epistemological foundation of feminist science and technology studies.

The following article by Lena Trojer connects feminist epistemology with the practice of scientific research, technological innovation, and institution building. She shows the implications of doing science and technology within a feminist framework of understanding technoscience as related to the social world of global power relations. She shows how to organize, institutionalize, and practice technoscience differently in order to attain knowledge and technologies which prove more suitable and therefore sustainable concerning equal opportunities for all genders in a global sense.

The third section is dedicated to reflecting un/equal conditions for participation in science and technology. How do traditional assumptions about women and men set limits to collaboration in fields of engineering? How do prevailing gender stereotypes influence the performance of individual women and men in science and technology? Which role do professionals play in this scenario and how can gender stereotypes be overcome in teacher education?

Based on an ethnographic investigation of engineering cultures, practices, and identities, Wendy Faulkner explains, how the numerical minority of women in engineering cause an in/visibility paradox and associated gender in/authenticity dynamics that undermine their professional membership and progress in this field. According to Faulkner, efforts to improve the representation of women in engineering are substantially limited by these dynamics. To

overcome these limitations she challenges stereotyped dualisms about gender and engineering and the "pervasive (and comfortable) ideology of gender dif ferences", to create space for more plural versions of masculinities, feminini ties, and more heterogeneous understandings of engineering.

Ilona Horwath, Nicole Kronberger, and Markus Appel examine the com plex interrelations between cognitive abilities, stereotypes, and successful performance in the field of science and technology. The authors summarize the current state of research on gender specific cognitive differences and sepa rate empirical results from stereotypical interpretations. To transcend the con straints of common 'nurture nature' discussions, they suggest raising the ques tion of how cognitive skills can be developed and influenced. For this purpose they provide a comprehensive review of studies that shows how stereotypes about gender and prevailing assumptions about the nature of intelligence and talent can influence individual performance and success in science and tech nology.

Gender competence in mathematics teacher education is the issue explored by Andrea Blunck, Anina Mischau, and Sabine Mehlmann. Starting from the finding that the 'male image' of mathematics is at least partially created in school, they argue for an implementation of gender competence in mathemat ics teacher education in order to increase equal opportunities for pupils be yond gender stereotyped knowledge and interest domains. With this in mind the authors elaborated an exemplary course concept in their interdisciplinary research project "GenderMathematics" and tested it in several German univer sities. The article discusses the most important facets of 'gender competence' in teaching mathematics and provides an overview of the course concept.

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the Petroleum Industry in Abu Dhabi, UAE") but also brought her students to broaden our students' horizon concerning assumptions about gender and culture in most valuable ways. Unfortunately, we cannot present her contribu tion in this volume. Many thanks to all other lecturers for their contributions to this book. We also thank our former professor and initiator of the lecture series, Gabriella Hauch, and all our colleagues at the department of women's and gender studies at the Johannes Kepler University Linz for their support as well as the rectorate of our university for their far sightedness in this regard. We are also grateful for the financial support for our lecture series given to us by the Austrian Ministry of Transportation, Innovation and Technology, the Austrian Minister for Women and Civil Service, the Women's Department, and the Department for Education and Society of the state government of Up per Austria, the city of Linz as well as the Bureau for Women's Affairs of the city of Linz, the Austrian Center of Competence in Mechatronics and some private sponsors. Last but not least we want to thank Matthias Müller for his professional proofreading of the entire manuscript and Maren Lachmund for her marvellously thorough editing and careful layout of the manuscript.

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