# The Social Construction of 'Design' as a Gendered Activity. Engineering Design and Socio-Technical Change

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# Abstract

In relating the social-constructivist approach in social science and in gender studies to the concepts of 'construction' and design in the field of technology, the paper illuminates the question of how the social construction of design can be considered a gender coded human activity. The major argument is that the concepts of the design activity in engineering show historical changes. Given this historical dimension, technology design in engineering is to be studied today under conditions of social change with respect to possible transformations of traditional gender codes.

# Introduction

Innovation, 'construction' and design of technological artifacts counts as one of the core competences of engineers and as their unique contribution to 'civilization' and innovation in the modern Western world. While today the social sciences (and the humanities) also highlight a certain notion of 'construction' and thus the perspective on the production of social and cultural phenomena, the relationship between both concepts of 'construction' is relatively undertheorized. Indeed, science and technology studies and also feminist technology studies have analyzed and problematized the pivotal social factors being relevant to the production of technological artifacts. Much less attention however is given to the social dimensions of methodological concepts in engineering themselves and to their gender relevance. Accordingly, in the following I want to shed light on the basic interconnection of both terms of 'construction'. I want to argue for the study of the concepts of the engineer's capability, activity and methods of inventing and designing machines from a social-constructivist and gender

perspective. I consider these concepts a historically specific formation of knowledge that shows a social dimension and thus a gender dimension. My broader argument is: this social dimension of engineering methodological knowledge plays a crucial role for the fact that engineering has remained a male domain until today.

Firstly, I am going to recall the basic historical lines of the term 'construction' as it can be found in engineering and art on the one hand (1) and in social science on the other (2). Following these lines, I will then develop the corresponding research question on gender in engineering design (3). The argument is made that gender codes have changed with the historical contingency of concepts in engineering (4). It can thus be expected that they are currently in transformation, too. Finally, I develop possible scenarios of how the gendering of technology design may undergo a process of change today (5).

# On the history of 'construction' in the field of technology

With reference to the history of *construction* theories, the field of technology shows the most prominent roots. As far as mechanical engineering is concerned, the historian Wolfgang König (1999) points out that a tradition of scientific design theories was first established in the later 19th century. It is closely related to the composition of the first pertinent textbooks in the course of the institutionalization of the training of engineers in higher education. The authors of those texts propose approaches that were supposed to make technology design teachable and learnable. Yet, they have to be assigned to different schools, each focussing on different aspects (see König 1999, 15-102). Two newly published studies give further indication of the guiding patterns in the respective field of engineering and also of its possible gender impact: In his historical longitudinal study on the development of design theories and approaches in mechanical engineering, Matthias Heymann (2005) traced in detail a pendulousness between an understanding of construction as a scientific and as a more or less artistic mode of operation. This supports the argument of recent \*\*\*IFZ/YB/08/Text 25.05.2009 10:43 Uhr seite 69

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philosophical thought on technology and design that addresses the tradition of design as being located between science and art (see Banse & Friedrich 2000).<sup>1</sup> With respect to the gender issue, the study of the German historian Karin Zachmann (2004) shows that the model of the engineering profession is anchored traditionally on the dualistic gender order of 19th century German civil society. Nevertheless, no specific evidence is provided of how construction as one of the engineer's central modes of operation was gender coded at that time.

Starting with this usage of the word *construction* for the work of engineers, the word arrived on the art and literature scene in the first decades of the 20th century, predominantly in connection with new avantgarde countermovements to former concepts of the artist. It is the figure of the 'artist-engineer' that also played a role in the context of engineering and that offered a link to combine both fields-technology and art. In this figure the individual is seen as the producer of an artifactual world in referring the contemporary societal context of technological civilization and industrialization. The programmatic texts on constructivism in the art scene of the 1920s in particular (esp. in Eastern Europe) had been devoted to the motif of the creation of a 'new' (socialist) world.<sup>2</sup> As drastically pointed out by Karel Teige (1925), the constructivist artistic movement considers the work of engineers to be art and vice versa. Teige looks at the piece of art as a product of rational calculation. By doing so he declares mathematical construction according to rational and functional criteria based on mere calculation activities to be a new aesthetic principle. He values the ideal machine produced by engineering principles as beautiful. In his emphatically loaded manifesto Teige plays with the opposites rationality and irrationality, calculation and intuition, in which an indication to traditional dualistic gender conceptions can be found. In the context of the cultural modern age, gender encodings transported in the aesthetic concepts of around 1900 have been demonstrated beyond constructivism, too. According to the study by Urte Helduser (2005), gender interpretations noticeably determine the programmatic shape of aesthetic production and of the relating concepts of authorship. One may conclude from her study: the concept of modern artistic production is conveyed in a dualistic gendered form.

Based on this fact, one can assume that the theoretical and programmatic foundations of technology design in industrial society also contain such dualistic gender concepts or are based on them and make use of them in their line of argument. With respect to the engineering field it is most likely that such gendering effects in central formations of technical knowledge and disciplinary approaches have also contributed to marking it as a male field. As professional sociological studies and the available gender research on work and occupation in related fields show, such rationales have been found in the history of multiple other (technical) professions until recently for the purpose of winning women over to a certain occupation or edging them out again.<sup>3</sup> These results already provide links to the social-scientific part of the term *construction*. They make it possible to correlate both uses of the term since gender and technology appear as contingent entities open to interpretation, that is they are socially constructed. I would like to break this down further as follows:

# On the term 'social construction'

The social-scientific usage of *construction* for the most part evolved in the second half of the 20th century. 'The social construction of reality' by Peter Berger and Thomas Luckmann (1966) introduced the key term 'social construction' (in a specific version) to the social-scientific and philosophical debate and provoked lively discussions. In common with technology design theories, the social-constructivist approach also shows a very heterogeneous tradition of the term. The hypotheses presented here argue on completely different levels and along different reference theories.<sup>4</sup>

From the perspective of epistemology and science studies, Ian Hacking (1999) puts the basic idea as follows: The 'social' construction hypothesis implies the opinion that an apparently self-evident phenomenon of reality is actually a product of social processes and norms (see Hacking 1999, 14 ff.).<sup>5</sup> He supposes that the hypothesis has an explosive impact primarily in those cases that criticize naturalizations. Accordingly, in his view, it has a predominantly political function, that is to say it questions existing naturalized versions of social classifications and shows their contingency.

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In this context one of the most challenging endeavours is the examination of the social construction of the findings of (natural) sciences and of the technological artifacts. Basically, the 'Social Construction of Technology' (SCOT) approach arrives at the conclusion that scientific and technological developments are to a lesser degree the result of fact-logical inner laws (of nature). They are rather the product of complex but also coincidental processes in which various societal protagonists bring about the respective solution along the lines of their specific constellations of interest (see among others Pinch & Bijker 1987; MacKenzie & Wajcman 1985/1999).

The social construction hypothesis is of major importance also and not least specifically in gender studies:<sup>6</sup> The idea of gender as a construction eventually leads to the opinion that gender is not determined by nature but socially generated and is thus also subject to social modification. The debate in the past 20 years was brought to the agenda above all by Judith Butler's 'Gender Trouble' (1990), Donna Haraway's critical studies on natural sciences and technology (see Haraway 1995) as well as by empirical ethno-methodological studies mainly from the Anglo-American world.<sup>7</sup> Current summaries of the debate document that although social-constructivist approaches have been established in gender studies, they are still the cause of controversial discussions (see Gottschall 1997; Helduser et al. 2004; Knapp 2000; Singer 2005).

To regard *technology and gender* as socially constructed (see among others Wajcman 1995) thus means to analyze the social processes and norms that are relevant in technology design and use. In her recent overview on feminist technology studies, Judy Wajcman (2002) sums up the existing state of the art: 'Currently there is a wide consensus that neither masculinity, femininity nor technology are standardized categories. They rather contain multiple possibilities and are constructed in relationship to each other' (Wajcman 2002, 285). Accordingly, she talks about the relationship between gender and technology as that of a *mutual co-construction*. This more or less broadly shared theoretical view has the quality of a critical analysis concept that can be applied particularly to the examination of the power relations in the field of technology and technology related work (see also Cockburn & Ormrod 1993; Faulkner 2001).

Based on these reconstructions of the main theoretical lines of argument regarding the term *construction*, I will now raise the question of how these lines interact and what research needs will result from that.

# The gendering of the engineer's design activity

When taking a closer look at the research on the mutual co-construction of technology and gender it is noticeable that the lines of argument of the existing studies are *product* rather than *process* related. On the one hand, they aim at evidence of contingency and thus the social dependence of the product, on the other hand at the description of the factors responsible for its accomplishment. Further focus is usually on the analysis of activities *with* the machine but not on designing *the* machine. Wendy Faulkner is of the opinion that the continued male dominance of engineering is due in large measure to the enduring symbolic association of masculinity and technology by which cultural images and representations of technology converge with prevailing images of masculinity and power (2001, 79).

In her research program she also mentions, among other aspects, the 'gendering' of knowledge and work styles in the field of technology. With respect to the study of other fields of work from a gender perspective, Karin Gottschall (1998), summarises that it has been broadly shown that not only the actors but also the work itself shows a gendered sub-text. That is, capabilities, workplace practices, qualifications and so on are continuously subject to gendering processes and closely related to the gender segregation of work. Nonetheless, the question has so far been virtually neglected and not explicitly examined as to whether the process of technology design, that is the activity of designing itself, is gendered, and whether such genderings in their turn refer to certain stereotypes of gender or mutually generate both concepts of design activities and of gender. This composition of the interplay between the two theoretical lines of the term construction thus implies a fundamental research need I want to point out here. The question how the engineer's central capability—the capability of creating machines—is mutually co-constructed with respective gender images is more or less under-researched to date. How can technological productivity \*\*\*IFZ/YB/08/Text 25.05.2009 10:43 Uhr Seite 73

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be analyzed as gendered and what ideas of masculinity and femininity do they contain? Consequently, my argument follows the proposition that the two versions of *construction* are also in a close mutual relationship in which gender is a significant category. Additionally, this refers to the fact that neither gender nor the conceptions of design can be seen as ahistorical entities but to a considerable extent as the result of social processes.

# The process of engineering design and social change

What has the historical impact of design theories been down to the present? I will sketch out some relevant lines starting with the time of high industrialization and outline some major aspects of today's transformations of design work, of technological concepts and organizational change.

It has already become evident by now that technology *design theories* are not ahistorical but should be considered historical documents themselves from a constructivist science critique angle. It can be assumed that approaches of engineering design as formulated in the modern 'industrial society' are marked largely by a more pronounced masculine image of the engineer that is related to patterns of rationalization, bureaucratization, and scientification.8 In her study on the early theoretical concept of the computer, Bettina Heintz (1993) points out that it was precisely contemporary thinking and the prevalent idea of rationalization that were essential for Alan Turing's work. The development of technology and of society converged in a historically specific knowledge about rule guided processes and systematic action. In the meantime computers have become increasingly important to the design work in engineering. That is, information technology being one of the outcomes of the scientification of various societal areas and the hegemonic way of thinking in the industrialized society started to shape the work of engineers themselves. The computer as a design tool in today's perspective can thus be understood not only as a matter of consistent continuation and radicalization of modern approaches to design. But today it also represents an object that embodies the crisis of this particular notion of *construction*. That is, the computer materializes an idea of design that is based on a model of linear rule guided

calculation and on the application of encoded scientific knowledge. Controversies that have arisen in the recent past on computer aided design (CAD) work point to inconsistencies, limits, rejections, and possibly also to the transformation of established process concepts of the modern age. Eugene Ferguson (1992) is one of the promoters of a design approach that implies a critical view on modern rationalist concepts. He highlights the relevance of incorporated implicit knowledge of experience in draft action and assumes something he calls 'The Mind's Eye'.9 This expression denotes an intuitive capability of the engineer in designing an artifact. Whereas such alternative experience-oriented approaches probably always run all the way through the actual design practice in everyday work, today the question is whether transformations have also occurred on the level of concepts and theories, which are of some significance regarding the gender constructions operating within them. There is thus a noticeable indication that the modern idea of design had changed significantly by the end of the 20th century. Taking a broader scope of view into account, this change in design concepts in engineering is embedded and takes place in the context of some other significant transformations and is interwoven with other discursive formations. Let me outline some major aspects:

Firstly, I can point at basic transformations in the concepts of computer science. Thus, Heidi Schelhowe (1997a) analyzed that the so-called micro-electronic revolution also caused a *change in the term 'machine*'. The privileged notion of machine is currently not as much a concept of a 'tool' but increasingly one of a 'medium'. As far as the broader technological field is concerned, there is also some indication of a change that was expressed in numerous *alternative plans for post-industrial technical processing and product models*. In computer science new approaches to software development were discussed already in the 1980s. They explicitly aim at being alternatives to the classic technological theories of design such as software engineering approaches.<sup>10</sup> The change in trend is also revealed in the choice of terminology in that the common German term '*Konstruktion*' is increasingly being replaced by the English term *design* (see Floyd 1987; 1994). The new approaches consider soft-

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ware development a result of a communicative process between several participants. It is accompanied by the change in the self-conception of computer science itself from a science of engineers to a science of design, as Christiane Floyd programmatically suggests. Additionally, Gerhard Banse (2000) from a philosophical point of view stresses the observation that more recent approaches in the engineering sciences increasingly develop cyclic instead of linear process models for technology design.

- Secondly, we can see that these technological concepts not only have a significant impact on science and engineering, but also on current social-scientific theory and research. Prominent diagnoses of society refer to those new forms of information technology as one of the predominant structuring principles, e.g. when talking about the 'information society'. I refer here to the hypothesis of Manuel Castells assuming an 'informational paradigm' which is associated with the 'Rise of the Network Society' (1996), the title of the first volume of his trilogy 'The Information Age'.
- Thirdly, the fields of economy and the state are currently also undergoing an essential change. At least since the 1990s, *processes of economic reorganization of work* have considerably influenced public discourse in society and politics. These processes are outlined by terms like 'organizational change' and other descriptions of a new, flexible, cooperatively and communicatively shaped capitalism, in short phenomena which are subject of widespread critical discussions (see among others Sennett 1998; Hardt & Negri 2000). In this context concepts of 'virtual' networks of global cooperation are also modelling new images of the subject and its capabilities (see Paulitz 2005).
- But also, lastly, the discourse on ecology which arose in the 1980s is one of the signs indicating change. In that discourse the conception of the technological civilization as the 'dominance on nature' was criticized and the idea of a sustainable development and adjusted technologies was appreciated, currently more and more culminating in the discourse on global warming.

The current technological transformations mentioned above have been hypothetically discussed by Schelhowe (1997b) from a gender perspective. She proposes that the conceptions of a male-coded technology have reached crisis point. She thus demands that these transformations be for the benefit of change also concerning the gender issue. This is where she sees the actual opportunity for women to actively get involved in the design processes of the new media technologies. Comparable arguments have been brought up in the context of diverse technological innovations before.<sup>11</sup> Yet, little is known so far about the impact of those transformations on the social construction of technology design and its gender dimension.

# Ways of gendering design today

Having in mind these theoretical discussion strands and the described phenomena of change, I see at least three possible ways of how design might be affected by gendering processes today in comparison with modern concepts of engineering design. I will thus conclude by giving hypothetic scenarios of processes for how the gendering of design may have developed and will develop in the context of these trends. Further research questions arising from the respective scenario are also indicated. In doing so, I intend to sketch out the scope for future empirical research on the social construction of engineering design as a gendered activity today. The scenarios are as follows:

- (a) Design concepts will be *fundamentally transformed*. This assumption is based on the idea that new gaps in the traditional gendering of design become increasingly noticeable and have the potential to undermine tendencies regarding the idea of the male engineer or to promote a slightly shifted social construction of technologically productive masculinity or femininity. The question here is whether theoretical concepts will show effects on the structural level of occupation and career for men and women and what kind of effects can be observed.
- (b) Design concepts and gender will be *disintegrated*. Gender increasingly loses its relevance for conceptualizing the engineer, assuming that

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today the reference to clear gender patterns has become problematic or traditional ideas are socially in a state of disintegration. The question arising from that is whether new social categories become relevant for the social construction of design activities and of what kind they may be.

(c) Design concepts will be strongly *retrationalized*. This scenario of gendering design implies a restoration of traditional ideas of gender arising within new argumentative margins, like e.g. the criteria materiality versus immateriality of the designed technological artifacts or formality versus informality regarding the modes of operation, e.g. in a design team. The question here is how processes of social segregation and distinction have to be reconstructed by including a wider range of social categories in a globalizing engineering market.

# Notes

- <sup>1</sup> From a philosophical point of view, Banse also considers the subject in the historical context going back to ancient and early modern times (see also Ropohl 1999).
- <sup>2</sup> For further studies on constructivism in art see among others Lodder (1992); Turowski (1994).
- <sup>3</sup> See e.g. Cockburn (1986); Wetterer (1992); for an international overview on and critical review of the discussion on 'doing gender while doing work' see Gott-schall (1998).
- <sup>4</sup> From the great quantity of existing sources I would like to mention only a few selected reviews predominantly referring to the field of science and technology studies, see Knorr-Cetina (1989) and Hacking (1999).
- <sup>5</sup> In that analysis he mainly refers to the so-called 'science wars' and the controversies made public under that label about the epistemological status of scientific knowledge.
- <sup>6</sup> Hacking also points out that the social construction of the category 'gender' must be understood as a core aspect in constructivist research (see 1999, 20).
- <sup>7</sup> Kessler and McKenna (1978); for an introduction and overview see Gildemeister (2004).
- <sup>8</sup> However, this relationship between technology and masculinity should not be considered too homological and too self-evident. As my empirical investigations on the basis of historical documents from mechanical engineering discourse so

far show, different, disparate and competing versions of the male engineer can be found (see Paulitz 2008).

- <sup>9</sup> This is the title of the book (Ferguson 1992).
- <sup>10</sup> Floyd (1994) gives an overview of this change in perspective followed here. See among others Schelhowe (2000) for the feminist view in the design-oriented approach, who also argues in favour of the media didactic aspect.
- <sup>11</sup> For an early study documenting the feminist research of technological change and gender in the organization of work, see Cockburn (1986).

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