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Rationality and Progress versus Natural Creative Talent

Constructions of Masculinity in Engineering and Technology around 1900

Tanja Paulitz

Abstract

The paper focuses on the gendered self-conceptions of engineers and their relevance for studying world exhibitions. It thus analyses debates in German engineering around 1900 on the relationship between technology and culture in order to reconstruct how masculinity in engineering is understood as a symbolic position of cultural production. This aim necessitates using a concept of 'hegemonic masculinity' as a relational construction. This is illustrated by the example of the professionalisation of modern German engineering from the 1870s on until the turn of the century. In their writings, engineering scholars initially constructed the idea of a 'scientist of machinery' as a symbolically neutralised position of objectivity by following a narrative of progress. Later, the engineer as a 'man of action' supplanted this concept, and emphasis was now placed on a narrative of the technological man whose competence was regarded a talent arising from the nature of his sex. Both historical conceptions of the German engineer are interpreted as a specific mode of masculinity construction, motivated by the need to attain a dominant position, not only with respect to women but also to other social groups of men.

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Introduction: world's fairs and technology

[1] In 1884, the mechanical engineer Franz Reuleaux (1829–1905), later rector at the Technische Hochschule Berlin-Charlottenburg, gave a lecture on the importance of technology in culture to the Niederösterreichischer Gewerbeverein (Lower Austrian Trade Association). The text was published in 1885 under the title "Cultur und Technik", given the status of a major contribution in the *Zeitschrift des Vereins Deutscher Ingenieure* (Z. VDI), and translated into American English in the same year.[1] By the end of the nineteenth century, Reuleaux was regarded as one of Germany's foremost protagonists in placing mechanical engineering on a scientific basis. Well known beyond academic circles, Reuleaux was actively involved in solving practical questions of technology and expressed his ideas publicly.[2] These wide-ranging activities included his service as a jury member at several world's fairs. In particular, his impressions and views of the 1876 world's fair held in Philadelphia, from where he reported in detail, attained prominence.[3] According to the technology historian Hans-Joachim Braun, for Reuleaux these world's fairs were a pivotal crystallisation point of culture, with technology considered an integral component:

> *Reuleaux always considered these fairs, which enjoyed significant publicity in the nineteenth century, as the exposition of the entire cultural activity of the exhibiting nations, not just as the presentation of technological innovations.*[4]

[2] In both the *Briefe aus Philadelphia*[5] and in a letter to the Reich Chancellery, Reuleaux criticised the German contribution to the world's fairs as "cheap and poor" [German orig.: "billig und schlecht"][6] from a technical viewpoint. He therefore campaigned for improving engineering education and upgrading the standards of technical products in the German Empire. Although his views drew fierce criticism, he was able to – as Braun describes it[7] – intervene in an already ongoing discussion and in this way contribute to initiating changes. Reuleaux's considerations on the cultural importance of technology are to be seen historically in direct relationship to the world's fairs of the time. For him, they were a stage for nations to present their achievements, whereby technology was accorded a pivotal role in evaluating the state of a culture. Reuleaux's fundamental understanding of the connection between technology and culture, so pointedly formulated in the publication of his lecture in 1884, i.e. quite some time after the Philadelphia fair, must be understood in the context of contemporary public debates about the importance

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[1] Franz Reuleaux, "Cultur und Technik", in: *Zeitschrift des Vereins Deutscher Ingenieure* 29 (1885), no. 2, 24-28 and no. 3, 41-46; Franz Reuleaux, "The Influence of the Technical Sciences upon General Culture", trans. by W. Kunhardt, in: *School of Mines Quarterly* 7 (1885), no. 1, 67-94.

[2] Cf. Hans-Joachim Braun, "Leben und Werk von Franz Reuleaux. Nachwort", in: Franz Reuleaux, *Briefe aus Philadelphia*, reprint, Weinheim 1983 (original edition: Braunschweig 1877), 113-151.

[3] Franz Reuleaux, *Briefe aus Philadelphia*, reprint, Weinheim 1983 (original edition: Braunschweig 1877).

[4] Braun (1983), 119. – Unless otherwise noted, the translations are mine.

[5] Reuleaux (1983) 5.

[6] Reuleaux (1983), 5.

[7] Braun (1983), 125 and 140.

and potential of technology for the competition of national economies[8] and of cultural sectors. It is thus of crucial significance for historical research on the world's fairs. With Reuleaux, it is possible to reflect on how the technologisation developing in the process of industrialisation sought to inscribe itself in high culture and exploited this inscribing for its own professionalisation as a new academic discipline. As we will see, this was accomplished by drawing on existing cultural conceptions of occidental masculinity.

"Cultur und Technik": context and the chosen approach

[3] As the title of the lecture "Cultur und Technik" indicates, Reuleaux's aspiration was sweeping. Arguing on the basis of the importance of mechanical engineering, he claimed that Western culture was pivotal precisely because of its modern technology, and moreover that this technology itself was preeminent in this culture, and hence, too, the role played by the engineer. Reuleaux's conception of the engineer is oriented on the ideal upheld by the educated middle-classes of the time, transposing the model of the profoundly educated intellectual worker to mechanical engineering.[9] He explained the cultural status of technology as stemming from Europe's superiority over other cultures, which, as will be elaborated below, itself had first been made possible through the achievements of a scientific approach to technology.

[4] "Cultur und Technik" is to be contextualised as an early document in a broader social debate that commences at the end of the nineteenth century and is characterised by the efforts of engineers to gain professional status. It first fully blossomed at the turn of the twentieth century and was mainly contested amongst cultural theorists but also involved a few engineers.[10] The spectrum of positions within the debate ranged from euphorically celebrating technological progress through to interpretations informed by cultural pessimism, which prophesised that a technologised civilisation would inevitably decline.[11]

[5] My reflections focus on what *engineers* contributed to this debate, above all how they countered the arguments put forward by cultural pessimists. In addition, I understand the engineers' considerations on this as crucial in the context of the professionalisation of mechanical engineering as an academic discipline. The articles written by engineers (mostly published in

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[8] Cf. Sebastian Remberger, "'Billig und schlecht'. Franz Reuleaux zu den Weltausstellungen in Philadelphia und Chicago", in: *Kultur & Technik* (2000), no. 3, 42-45.

[9] Cf. Hans-Joachim Braun, "Methodenprobleme der Ingenieurwissenschaft, 1850–1900", in: *Technikgeschichte* 44 (1977), 1-18; Karin Zachmann, *Mobilisierung der Frauen. Technik, Geschlecht und Kalter Krieg in der DDR*, Frankfurt/Main, New York 2004.

[10] Cf. Hans-Joachim Braun, "Technik als 'Kulturhebel' und 'Kulturfaktor'. Zum Verhältnis von Technik und Kultur bei Franz Reuleaux", in: Burkhard Dietz, Michael Fessner and Helmut Maier, eds., *Technische Intelligenz und "Kulturfaktor Technik"*, Münster 1996, 36-43: 42. For an evaluation and appreciation of Reuleaux's early contribution in the context of the heated debates of the 1920s, see the contemporary book by Carl Weihe, *Franz Reuleaux und seine Kinematik*, Berlin 1925.

[11] Burkhard Dietz, Michael Fessner and Helmut Maier, eds., *Technische Intelligenz und "Kulturfaktor Technik"*, Münster 1996; Thomas Rohkrämer, *Eine andere Moderne? Zivilisationskritik, Natur und Technik in Deutschland 1880–1933*, Paderborn, München, Wien, Zürich 1999.

specialist engineering journals) thus bear the character of a self-understanding about the importance and status of their own position. How they deal with the question of the relationship between technology and culture is therefore to be evaluated as part of the internal specialist discourse of engineering. And this, too, is part of the topic I am addressing: the discourse conducted in engineering and the internal production of expert knowledge as power knowledge on technology, engineering, and culture.

[6] Around 1900, the field of engineering developed into an academic discipline and became professionalised, affirming both the foundations of knowledge and the social significance of engineering. An examination of the debates and discursive campaigns during this period reveals the most important cultural thought pattern that guided engineering in Western modernity, which will be analysed in more detail below. In this context, I focus on the formation of engineering as a male-connoted discipline, examine the various formations of masculinity that hence emerged, and consider them in terms of their entanglement with questions of technological progress, Occidental or national efficiency and capability, and social status.

[7] In this essay, I do not address the structural situation of women engineers, nor the question of how many women participated in engineering, nor the barriers erected to prevent women from entering, nor the mechanisms that excluded them from the male domain. Rather, I am interested in the symbolical construction of the engineer as modern technological sciences evolved, namely in its gendering, a gendering that, as Ruth Oldenziel has put it, "is often taken for granted".[12] Frequently unquestioned, this cultural assumption of a masculine coding of technology ensues without us gaining any further insight into its internal constitution, its genealogy, its ruptures, and consequently the historical contours of thought in the field of technology. This article is hence devoted to the engineer as the protagonist of technology, the cultural field that is certainly of key importance for examining the world expositions. My focus specifically is on the German engineering tradition and its genealogy in the second half of the nineteenth and the beginning of the twentieth centuries.

[8] Guiding the considerations is a perspective on masculinity that has shifted away from conceiving it per se as a self-enclosed, homogenous, and stable entity; instead, it is approached as a constantly relationally produced cultural construct, one that is historically changeable, reveals field-specific characteristics, and can become the subject of symbolic conflicts. Thus, in its relationality, as one can surmise from the studies of masculinity expert Raywyn Connell,[13] masculinity does not only always have a relationship to femininity, but also to other masculinities. But moving beyond Connell, I also suspect that there is a relational positing to field-specific relevancies, so that the masculinity discourses produced in specific fields need also to be understood as part of the power-knowledge organising the field at a specific juncture in time, affecting its social position, and hence its importance. Accordingly, I understand masculinity also as part of the symbolic resources with which actors fight for their social positioning in discursive practices, and thus reveal a moment of contentiousness in cultural power struggles.

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[12] Ruth Oldenziel, *Making Technology Masculine*, Amsterdam 1999, 9.

[13] Raywyn W. Connell, *Masculinities*, Cambridge, UK 1995.

[9] My interest is thus focused on a field of knowledge production emerging around 1900, namely that of mechanical engineering, which, as the German Reich pressed ahead with rapid industrialisation, found itself undergoing a process of scientification. It is a field in which engineers gathered together, reflected internally on and formulated their roles and aspirations, and subsequently fought for their social status.

[10] In the following I will approach Reuleaux's lecture on "Cultur und Technik" as a salient example – and hence as a key text – of how Eurocentric and gendering aspects became entwined. I shall then contrast it with other (controversial) lines of argument in the engineers' debates on the culture question, presenting two, contemporarily conflicting, conceptions of the engineer crystallising and competing with one another between the 1880s and 1900.[14] Both conflicting conceptions of the engineer seem to be present in the interpretations of the national contributions to the world's fairs. Thus the contributions of the relatively new German national state to the fairs stimulated also a plea for different approaches in the scientification of engineering and the rise of engineering universities, namely as specifically capable for promoting national achievement potentials.[15]

[11] The considerations presented here are based on a broad corpus of specialised writings in the emerging modern technical sciences, which I have collected and examined as part of an exhaustive study.[16] Selected from this corpus are those texts which were written by engineers as contributions to specialist debates on the cultural significance of technology. For the overall study, the *Zeitschrift des Vereins Deutscher Ingenieure* (Z. VDI) and the journal *Der Civilingenieur* were systematically studied and assessed from the 1850s through to the 1920s, while also taking into consideration relevant textbooks on the science of technology. Based on the analysis of the subject indexes of the journals, relevant articles were identified and categorised as follows: professionalisation and scientification, cultural significance of technology, construction theory, machinery theory, and engineering education.[17] For the selection of historical textbooks, I drew on recent research studies into the history of technology that provided access to source materials.[18] An additional criterion for my selection was the importance of such textbooks for the

[14] Cf. Braun (1977).

[15] Cf. Mathias Heymann, *Kunst und Wissenschaft in der Technik des 20. Jahrhunderts. Zur Geschichte der Konstruktionswissenschaft*, Zürich 2005, 64; Klaus Mauersberger, "Die Herausbildung der technischen Mechanik und ihr Anteil bei der Verwissenschaftlichung des Maschinenwesens", in: *Dresdner Beiträge zur Geschichte der Technikwissenschaften* 2 (1980), 1-52: 32.

[16] Cf. Tanja Paulitz, *Mann und Maschine. Eine genealogische Wissenssoziologie des Ingenieurs und der modernen Technikwissenschaften, 1850–1930*, Bielefeld 2012.

[17] The subject indexes provide a broad access to the contents of the journals for this period. Besides the main lectures given at large VDI meetings and expert key articles, they also list the 'minor' genres like reports from district associations, reviews, diverse news, etc.

[18] Braun (1977); Mauersberger (1980); Wolfgang König, *Künstler und Strichezieher: Konstruktions- und Technikkulturen im deutschen, britischen, amerikanischen und französischen Maschinenbau zwischen 1850 und 1930*, Frankfurt/Main 1999; Matthias Heymann, *"Kunst" und Wissenschaft in der Technik des 20. Jahrhunderts. Zur Geschichte der Konstruktionswissenschaft*, Zürich 2005.

specialist field, which was gauged from the reviews in the journals mentioned. The writings were evaluated as part of a focused discourse analysis.[19]

[12] The analysis in this paper first concentrates on Reuleaux's "Cultur und Technik", and then examines the counter model to Reuleaux, which, historically later, no longer sees technology as the product of a scientific position of progress based on an androcentric conception of the 'masculine'-coded engineer. Rather, this later model follows a naturalised version of masculinity, which becomes a resource of cultural creative power.

The 'Atlantic', highly-qualified machine scientist

[13] Over the course of his argumentation in "Cultur und Technik", Reuleaux develops his own dualistic conceptual system for cultural productivity. Pivotal is the conceptual pairing of "manganism" and "naturism"[20] which characterise two contrary ways of dealing with natural resources. Before elucidating these concepts, I would like to sketch a few of the main lines of the overall argument.

[14] The decisive foundation of Reuleaux's argumentation in "Cultur und Technik" is his academic work in machine theory, the principles of which he extrapolates to more general cultural conditions and the world order. The overarching objective of his article is to inscribe technology into Western civilian bourgeois culture and gain recognition of technological creativity as a major intellectual activity, whereby engineers would assume the role of the main bearers of culture. Reuleaux is thus working on introducing and systematically establishing technology as a foundational condition for cultural development and a standard for gauging a culture's stage of development. In Reuleaux's assessment, although contemporary culture is essentially based on technological developments and technology has first made modern lifestyle possible, society has yet to properly appreciate and recognise technology's role. Of decisive importance in changing the status of technology is the scientific foundation achieved in machine theory, which elevates it into the position of being a relevant factor in cultural production:

> *The useful arts, scientifically developed, have not as yet been accorded a sufficiently extended and deserved recognition as a factor [and] as a powerful lever in elevating the standard of general culture.*[21]

Hence, Reuleaux is not solely concerned with the outward economic importance of technology for modern society, but is pursuing a more subtle goal – to elaborate an internal connection between technology and culture.

[15] The conceptual pairing of "manganism" and "naturism" forms the general starting point for systematising phenomena. Reuleaux conceives the 'manganistic' approach as an intervention characterised by a "penetration into nature's secrets",[22] an intervention that ultimately finds its

[19] Cf. Paulitz (2012), 79-99.

[20] Reuleaux (1885), 74.

[21] Reuleaux (1885), 67.

[22] Reuleaux (1885), 73.

purposive rational application in the construction of machines. Reuleaux derives the term from cultural history, referring to the early history of the Persians, to a "tribe of the Magi" mentioned there and to the later uses of the term "*manganon*" in ancient Greece, designating "any skillful device or any arrangement by which extraordinary results were achieved".[23] The "magicians" thus knew how to entice nature to reveal her secrets, her laws. In contrast, "naturism" is actually "against the study of nature, or at most, in ways mysterious and beguilded", so that it snatches merely "whispers" of nature.[24] The conceptual pairing is thus structured as polar principles, serving furthermore to hierarchise "civilisations" [German orig. "Völker"], and distinguish between stages of development in individuals, and socially stratify the (technical) education system.

[16] The first argumentation step in "Cultur und Technik", the hierarchising of "civilisations", takes its starting point from a perspective comparing cultures and focusing on competition, which is presumably similar to the main focus used to judge exhibits at the world's fairs: Reuleaux seeks to identify the reasons behind the dominance of the Europeans and North Americans – he calls them the "Atlantic nations"[25] – over the "other five-sixths of mankind".[26] In his view, the extraordinary achievements of the "Atlanticists"[27] stem from a specific way of thinking that is – historically – newly acquired, one that essentially corresponds to a technical rationality oriented on the natural sciences. It emerged out of the critical scrutiny of the formerly dominant conception of a divine world order, which, necessitating a clear distinction, represents a "difficult, hazardous ascent, to higher and freer interpretations of nature".[28] And to underline the uniqueness of this achievement of Western culture, he describes the scenario of a failed intellectual struggle in the Arab world:

> *[…] we can see it, we can note the very thing in the fate of the great Arab family of nations. Their reaction had really carried the day. [...] Arabian culture [...] has lain, stunned, paralyzed in every limb, for half a thousand years. Allah aalam! 'God only knows!' And hence – 'nothing is that thou must want to know!'*[29]

[17] Here Reuleaux sets up a contrast between "the heavy mass of deadened minds" in Arab lands and the 'will to knowledge' and the spirit of 'free and independent inquiry' of the "Atlanticists". A nation can practically decide for itself to join the unimpeded and enlivening momentum generated by the idea of progress and 'march along'. With the dualism of "manganism/naturism", Reuleaux inserts this antithesis in intellectual capacity between "civilisations" into a binary conceptual system.

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[23] Reuleaux (1885), 73.

[24] Reuleaux (1885), 74.

[25] Reuleaux (1885), 69.

[26] Reuleaux (1885), 69.

[27] It remains unclear if Reuleaux's "Atlanticists" is referring to Francis Bacon's *Nova Atlantis* (1627).

[28] Reuleaux (1885), 71.

[29] Reuleaux (1885), 72-73.

[18] This system serves to classify "civilisations", whereby he describes cases of both 'manganistic' and 'naturistic' nations as well as some 'in transition'. Assuming a global war for dominion, Reuleaux claims that "every observer can predict with certainty that the manganist will issue victorious from the conflict, or that those nations which cannot resolve upon adopting manganistic tenets must face the alternative of subjection and decay".[30] Based on this line of argument, Europe can claim dominance as its entitlement, for it is not only objectively justified in its 'proper' intellectual approach, but moreover has been rightfully acquired by the scientific-rational subject of progress, the 'civilised people'. Ultimately then, Reuleaux's hierarchising of the nations is based on the capacity to produce scientific approaches to technology or sciences of machinery respectively. Mediated in these terms, the question of technical productivity turns into a justification of colonial rule.

[19] Reuleaux explains in detail the 'manganistic' work of engineers by referring back to the kinematic machine theory he had earlier expounded in his 1875 textbook.[31] He makes use of the procedure proposed there – namely to develop machines on the basis of systematic (scientific) analysis of the tiniest functional, mechanical machinery elements – as an overriding abstract principle in his cultural theoretical considerations, following the argumentative logic: the more complex a kinematic-constructed machine is, the higher the level of culture that was capable of producing it.[32]

[20] Without any consideration, Reuleaux simply assumes for both the 'manganistic' and 'naturistic' that a man is meant. On closer inspection, however, there is one passage in the text – and there it occurs only *en passant* – where it is explicitly stated and hence evident on the textual level after all. The argumentation step proceeds as follows: Reuleaux attempts to prove the different capabilities of the 'civilisations' on the basis of mathematical calculations, seeking to lend his argumentation a scientific dignity. He selects as a comparative measure industrial labour power and productivity, specifically the example of mining coal and its equivalent of (industrial) output, translating horsepower into the amount of physical work performed by a human: "allowing as the equivalent of each horse-power the work of six strong men [...]".[33] Here Reuleaux compares the productivity of working men from different 'civilisations' and thus adopts an androcentric position, unquestioningly ascribing labour power and productivity to men. This consideration leads him in turn to the following conclusion:

> *We Atlanticists, the one-sixth portion of our earth's inhabitants, consequently accomplish with our manganistic work far more than four times as much as the others possibly can. The preponderance of manganists over naturists is not casual, therefore, but has been earned and paid for in useful work, and attains thereby, in a purely material sense, its justification. And all the more is this true, because much of our work is*

[30] Reuleaux (1885), 74.

[31] Franz Reuleaux, *Theoretische Kinematik. Grundzüge einer Theorie des Maschinenwesens*, Braunschweig 1875.

[32] Reuleaux (1885), 89-90.

[33] Cf. Reuleaux (1885), 90 (emphasis by T. Paulitz).

> *conveyed [...] for the dissemination and growth of civilisation and culture. Thus it is that technical science becomes the propagator of general culture, a vigorous and indefatigable worker for the melioration and advancement of the human race*.[34]

[21] With respect to industrial work, Reuleaux consequently distinguishes two forms of productive masculinity along the opposites of physical and intellectual power. In doing so, he also indirectly elevates technology, produced by the capacities of technical science (i.e. 'manganistic'), to the bearer of general cultural values. For along with material culture, the norms and values of the "Atlanticists" are disseminated throughout the world and secured by the material technical basis. Reuleaux's main concern is not so much to justify colonial domination (while however factually doing so), but rather to point out the unique cultural significance of a scientific approach to technology, i.e. the project of modern engineers. But precisely this cultural significance of technology is possible due to a positioning of the 'Atlantic' engineer, one that is the product of multiple social relations: the hierarchical gender order of the capitalist-bourgeois societies of Europe and North America and, concurrently, a colonial order with the opposites, sketched here, between North and South, 'Occident' and 'Orient'.

[22] In a second step in his argumentation, Reuleaux employs the concepts of "manganism" and "naturism" to the idea of qualitatively different stages of individual development:

> *But we need not go to distant lands in quest of naturism, for here in Europe we may find it still; indeed, we can detect a trace of it in every living man. It is only through education that manganistic modes of thought ally themselves to man's own self; that the higher rational faculties and dispassionate logic are linked to the naïve and to whatsoever in man is fair nature's unconditional devotee; but then this intellectual balance gives growth and calm deliberation, and enduring steadfastness against assaults of nature that threaten ruin – in a word, it develops a type of character absolutely antagonistic to fatalism.*[35]

Even individual development moves from an innate "naturism" to an acquired "manganism". This generalising application of the dualistic classificatory principle gives rise to a close referential connection to human and collective development and the global power struggle amongst 'civilisations'.[36] By implication, in this way Reuleaux naturalises the colonial hegemony, for it appears as the result of the evolutionary development of a people from an allegedly given early stage to an advanced superior one. Moreover, ensuing from this observation is an additional classifying of the differently ranked 'civilisations' into an all-encompassing nature/culture dualism. Aided by this, Reuleaux eventually distinguishes – in a third step – between various, hierarchically-structured levels of the technical education system, between superiorly educated ('manganistic') engineers and simple ('naturistic') technicians.

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[34] Reuleaux (1885), 90.

[35] Reuleaux (1885), 76.

[36] This argumentation figure functions thanks to the implicit reference to the Social Darwinist position of Ernst Haeckel, in which phylogenesis and ontogenesis were conceived as parallel evolution processes.

[23] Ultimately, in "Cultur und Technik", employing this conceptual pairing means that the group of genuine 'manganists' is extremely small. And they are European men, highly qualified in the new sciences of machinery à la Reuleaux, an elite for whom he demands social recognition and a status matching their role as producers of culture. The dualistic classification criterion itself gains, conversely, the status of a universal law through its application to the three different fields, similar to the claim of the general validity of the laws of nature.

[24] Following Connell, Reuleaux's construction of the 'manganist' may be interpreted as a specific conception of hegemonic masculinity that emerges over the course of the professionalisation of modern engineering. Here, too, the "relational character" becomes evident.[37] The respective conception claiming hegemony is constituted by expressly comparing itself to and distinguishing itself from an 'other'. What is interesting is that the 'others' here are not exclusively women. While Reuleaux's argumentation is based on the unspoken self-understanding of an androcentric mode of thinking, so that only technologically productive men come into question, to draw a distinction from the 'others' however, explicitly ethnic categories and social hierarchies in the contemporary education system are adduced. In summary at this point, it may be stated that for Reuleaux the specific ability of the engineer to design and build machines is the pivotal argument for cultural superiority. And conversely, this superiority entails improving the social status of the academically educated engineer in the German Empire and according him the social recognition befitting technical productivity.

[25] These social constructions of 'technical masculinity' have a very concrete background, albeit one that is not immediately obvious in the sense of a simple cause-and-effect mechanism: at around 1900 engineers were in the critical phase of the process of their academic professionalisation. Graduates from polytechnic institutes felt that they were socially underprivileged, in part because their diplomas were not granted the same status as university degrees. This self-perception as an underprivileged profession is thus to be traced back to the barriers obstructing engineers from access to higher career paths, above all in public administration and positions of political decision-making.[38] Reuleaux's argumentation strategy, namely to highlight the scientific rigor and ingenuity at the core of technological productivity and its performance potential in the colonial world, a perspective inherent to the world's fairs, is thus embedded in the context of a struggle for equality with other academic vocations. The social position claimed in "Cultur und Technik" on the basis of the value of a scientific approach to technology must therefore be interpreted as an attack on the educated elite of the time and as an attempt to increase the political influence of a profession. Unmistakable however are the imperialistic ambitions of Germany at the end of the nineteenth century,[39] with Reuleaux emphasising the contribution engineers are making to the nation's ascendancy in the world and basing the hegemonic claims of the new profession precisely on this contribution.

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[37] Connell (1995), 188-189.

[38] Cf. Dietz, Fessner, Maier, eds. (1996).

[39] Cf. Dirk van Laak, *Über alles in der Welt. Deutscher Imperialismus im 19. und 20. Jahrhundert*, Munich 2005.

Vigorous, artistically creative technical masculinity

[26] What is banished to the lower stages of 'naturism' as part of Reuleaux's constituting of the engineer as a scientist of the machine and exponent of cultural progress reappears in other contributions from engineers to the theme of culture in strongly altered form and a new entitlement mentality. It may be read as a competing model of the engineer as a producer of culture. Reuleaux's internal opponents in the controversial and polarising theoretical and methodological debates around 1900 rejected the image of the engineer strongly oriented on a scientific ideal, underlining instead a conception of technical productivity that put forward a revitalised version of skilled artisanal practice.[40] Alois Riedler (1850–1936) is considered to have been the most prominent opponent. As Reuleaux, Riedler attended the world's fairs. He was appointed rector at the Technische Hochschule Berlin-Charlottenburg in 1899, having not least made a name for himself on the back of his considerations on engineering education in machine construction. Also, he was the first professor for machine construction who was allowed to run a private engineering bureau at the polytechnic university to meet his demand for lending academic education in machine construction greater practical relevance. Riedler's model (1896) of the engineer is that of the practicioner.[41] Distinguishing this ideal sharply from that of the educated bourgeoisie, he provocatively places a 'man of action' above the mere 'theorist' and, offensively pressing his claim, understands the actions of the engineer to be art and not science. This new argumentation is a (strategic) turning point in the struggle of engineers for hegemonic masculinity.

[27] Max Eyth (1836–1906) for example, a well-known contemporary 'poet-engineer',[42] takes the same line and offers a vivid description of the process of technical cultural productivity. In 1904 he published the programmatic text "Poesie und Technik", which also appeared in the *Z-VDI*, and wherein he characterised the working process of the engineer as:

> *[...] the dark drive to create, the half-unconscious play of imagination, unrelated memories and tattered thoughts rolling in; and then suddenly glimpsing a way out, a light in the murkiness, one that appears not to be dependent on any will, that comes from just one direction, a direction the discoverer had not even thought of in that moment. And then the exultant joy when the light becomes brighter and clearer with each moment, and finally the certainty trembling through every fiber of the man: and once again a new truth has been found!*[43]

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[40] Cf. König (1999), 55-57.

[41] Cf. Alois Riedler, "Die Ziele der technischen Hochschulen", in: *Zeitschrift des Vereins deutscher Ingenieure* 40 (1896), 301-309, 337-346, 374-382.

[42] The term 'poet-engineer' was used to describe those engineers who came to prominence by poeticising the engineering profession. Around 1900, such texts were mostly reminiscent of the genre of heroic epics and presented the engineers' struggles with the forces of nature in literary form (cf. Karin Zachmann, *Mobilisierung der Frauen*, 120ff.). That literary texts were quite frequently written by actors from the technological professions, is also demonstrated, for example, in the study on technological utopias in the USA, cf. Howard Segal, *Technological Utopianism in American Culture,* Chicago/London 1985.

Eyth turns masculinity into an emphatic programmatic criterion of performance and achievement when he writes: "The imagination and the will, the vigor and the masculinity, which have created all these things are still fully active today and continue to work on opening up limitless possibilities."[44] In other words: in Eyth's conception of the engineer, the embodiment of the artistic-combative creativity, gender is set as the explicit marking and resource of technical culture. The colonial-imperialistic motif of 'opening up limitless possibilities' resonates here merely in the background. Linking into the traditional conceptions of artistic action and the genius discourse of German Idealism, this alternative to scientific-technical rationality is not excluded from the field of technology, but in fact euphorically celebrated. In this way, attributes traditionally encoded with femininity in the bourgeois ordering of gender[45] – feeling, intuition, and passive receptivity – are mobilised for technology and a masculine creativity and designated to be the nature of the male sex. The discursive connector here is art. The reference to the artist as the exceptional subject of modernity enables von Eyth to reclaim anti-rational attributes and nevertheless – or perhaps therefore – lay claim to a hegemonic position. Like the work of art, the machine appears to be the result of an inner powerful, non-rational capability. In this conception, technical cultural production is enveloped in a mystery. Masculinity becomes a creative resource.

[28] As Urte Helduser has shown in an analysis of programmatic writings on literature from the turn of the century, there exists in the domain of cultural modernity a strongly sexualised and gendered discourse on aesthetic productivity.[46] Technical productivity thus needs to be placed within a broader discursive field on productivity since the eighteenth century. Drawing on Jochen Schmidt's considerations on the history of the idea of the genius[47], it is possible to see the self-conception of the engineer as a thematic strand, positioned within a broader problematising of economic and artistic productivity and connected with the transformation of bourgeois society. As Schmidt relates, the conception of the genius not only mirrors the new self-confidence – based on productive vitality – of the citizen in general, but specifically the notion of the artist as the autonomous creator of his works.[48]

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[43] Max von Eyth, "Poesie und Technik", in: *Zeitschrift des Vereins deutscher Ingenieure* 48 (1904), no. 31, 1129-1134: 1132.

[44] Eyth (1904), 1131.

[45] Cf. Karin Hausen, "Die Polarisierung der Geschlechtscharaktere. Eine Spiegelung der Dissoziation von Erwerbs- und Familienleben", in: *Sozialgeschichte der Familie in der Neuzeit Europas*, ed. Werner Conze, Stuttgart 1976, 363-393.

[46] Cf. Urte Helduser, *Geschlechterprogramme. Konzepte der literarischen Moderne um 1900*, Köln, Weimar, Wien 2005.

[47] Cf. Jochen Schmidt, *Die Geschichte des Genie-Gedankens in der deutschen Literatur, Philosophie und Politik 1750–1945*, Darmstadt 1985.

[48] Cf. Hausen (1976), XVI.

Conclusion

[29] As this analysis shows, at least two different self-conceptions can be traced in the debates conducted by engineers on the question of the relationship between technology and culture around 1900. On the one hand, the engineer is characterised as the rational machine constructor and the active subject of technological progress, justifying an elevation of cultural status. On the other, he is the genial machine artist whose masculinity is seen as the creative natural resource *par excellence*. Both conceptions claim in their specific ways the preeminence of the German engineer in cultural production.

[30] We may assume that the German contributions to the world expositions embodied the patterning of these conceptions of the engineer, with both shaped by specific versions of the intertwinement of Eurocentric and gendering aspects. While the historically earlier conception adopts an androcentric form of neutrality and rationality which is, to draw on Reuleaux, explicitly labeled a 'Western' (or respectively German) technological culture, the later conception of the engineer represents a more aggressive masculinisation of culture and technology, the superiority of which is claimed to derive from nature itself. At first glance this may seem to be located in the ahistorical framework of a natural order, with the colonial-imperialistic motif of discovery and 'limitless possibilities' merely resonating in the background, but a closer look reveals a strong link to the idea of a superior nation.[49] As Alois Riedler puts it, engineering education should be dedicated to producing "technicians for the nation".[50] This idea fits in seamlessly with the imperialistic goals of the German Empire to join the other major powers in the colonising project.

[31] World's fairs thus served as a stage to present German culture to the world, notably by focusing on technological achievements. At the same time, engineers sought to understand technology as a pivotal expression of their own culture and thus did all they could to inscribe engineering and technology an active and determinative presence in high culture and even in the fine arts. Reuleaux's involvement with the world's fairs is testimony to the enormous importance attached to these platforms for promoting the status of the country by notably focusing on technology not only as a product of the specific economic potential of a nation but also as a proof of the leading cultural significance of a developed Western 'civilisation'.

[32] So when Reuleaux served on the jury of several world exhibitions and reported on these events, and when he publicly criticised the German contribution in Philadelphia as "cheap and poor", the question arises as to how this assessment relates to his vision of the engineer. In this regard, it is first important to know that Reuleaux, for all his orientation toward the scientification of technology, was of course always concerned with the practical issues of industry and technical education. Thus, Braun argues forcefully that Reuleaux was not simply a theorist, but possessed the roots in a practical technical education that were common for his time, and was also always interested in practical problems of technology.

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[49] Cf. Paulitz (2012), 178-181.

[50] Cf. Riedler (1896), 340.

> *Reuleaux, who would later become known and even famous primarily for his achievements in the field of engineering, thus dealt extensively with practical problems prior to his studies. This was the rule, not the exception, around the middle of the 19th century – at least in Germany.*[51]

It is also Braun who directly relates Reuleaux's ambitions in improving technical education to his comments on the Philadelphia world's fair:

> *At the very time Reuleaux was writing his "Briefe aus Philadelphia" and his letter to the Reich Chancellery, the discussion about the inadequacy of the provincial trade schools was at its height. Due in no small part to Reuleaux's efforts, these schools disappeared after 1878.*[52]

[33] The presentation of German engineering achievements at the world's fairs was consequently important both externally, in the competition between national economies, and internally, in influencing the standards and institutions of engineering education in the German Empire. They were a stage (certainly not the only one) on which the goals of an academicised engineering elite were enacted. Associated with this was the prospect of the Technische Hochschulen gaining equal status with the universities and thus becoming institutions of higher learning that would be an attractive option, especially for the sons of the bourgeoisie. On the basis of the analysis presented here, therefore, this perspective needs to be broadened. For less frequently noticed in this context is that world's fairs were also, conversely, of major significance for promoting the status of the engineering profession itself and hence its gendered formation. In this way, these fairs not only served as mediators of Western masculinities but also opened up the cultural spaces necessary for making modern formations of technological masculinity visible and popular beyond the narrower confines of engineering and industry. Further research promises to shed more light on how these ideas of engineers on technology, culture, and Western masculinities materialised in the specific expositions at the world's fairs and how they changed over time.

[51] Braun (1983), 114.

[52] Braun (1983), 138.

About the Author

Tanja Paulitz is Professor of Sociology at the Technical University of Darmstadt. Her work focuses on researching processes of mechanisation and the occupational profile of women and men in the natural sciences and engineering. She analyses and describes gender norms and gender roles in the world of technology. In particular, she deals with the gender attribution of technical knowledge, such as in: *Mann und Maschine: Eine genealogische Wissenssoziologie des Ingenieurs und der modernen Technikwissenschaften, 1850–1930*, Bielefeld 2012.

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