Made in Germany

Technologie, Geschichte, Kultur

Herausgegeben von Shaul Katzir, Sagi Schaefer und Galili Shahar

Wallstein

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Tel Aviver Jahrbuch für deutsche Geschichte
Minerva Institut für deutsche Geschichte
Universität Tel Aviv, Ramat Aviv
Tel Aviv 69978, Israel
Telefon: 00972-3-6409731
Fax: 00972-3-6409464
hisgerm@post.tau.ac.il
http://www.tau.ac.il/GermanHistory

Gesamtredaktion und Lektorat der deutschsprachigen Beiträge: Ursula Kömen
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*Shaul Katzir * Sagi Schaefer * Galili Shahar*

Editorial

Made in Germany

The term, »Made in Germany« has an ironic history and an ambivalent meaning. Originally intended to be a warning against low-standard goods, it soon became a mark of high-quality products and has remained so ever since. Yet, as an indicator of excellence, it (like technology in general) has occupied a problematic place in the German self-image since it signified practicality and materiality in the *Land der Dichter und Denker*. For the victims and their communities during and after the Second World War, it became a loaded term that associated the products of German industry with Nazi atrocities and the Holocaust. Nonetheless, even in their eyes, it was also a sign of pedantic expertise and robust, durable products, and a cause for admiration, often linked to German military power. In Israel, the term and the products that carried it, like virtually anything German, were controversial and charged with symbolic meaning. »Made in Germany« was also the death industry of the 1940s. German factories, the gas industry, trains, labor and production evoked mass murder and *Zwangsarbeit*, conquest and destruction. The idea of German (technical) mastery was essentially affiliated with death: »Der Tod ist ein Meister aus Deutschland« (Paul Celan).

Since this volume is edited in Tel Aviv, we begin with a short discussion of the history of the term in pre-state Israel before discussing the articles in this year's *Jahrbuch*, which addresses the theme of technology in German history and culture. In his introduction to *Rituelle Distanz: Israels deutsche Frage*, Dan Diner writes: »Alles, was nach der jüdischen Katastrophe und der auf sie folgenden Staatsgründung auf Deutsches verwies, galt als anstößig, verwereflich, gleichsam kontaminiert. Deutschland war ein gebanntes Land.«[1] Already in the 1930s and during the Second World War, there were calls in the *Yishuv* (the Jewish settlement in Palestine) to boycott »Hitler's produce.« After Hitler was appointed prime minister in January 1933, and especially when the German government called for a boycott of Jewish businesses on April 1 of that year, this issue began to preoccupy

1 Dan Diner, Rituelle Distanz: Israels deutsche Frage, München 2015, 7.

Jews throughout the world. Orthodox Jewish communities in eastern Europe implemented the ban on German goods more strictly than communities elsewhere, but it probably aroused the most public attention in the United States with the mass rally in Madison Square Garden in New York City in March 1933.[2]

The Jewish community in Mandatory Palestine occupied a particularly precarious position with regard to the boycott. German products, such as Osram light bulbs, were bought and sold in Mandatory Palestine from the 1920s at least.[3] Very early on, the boycott campaign caused conflicts within the *Yishuv*. Following the legislation in Germany designed to drive Jews out of the country, the Jewish Agency and the German government signed the *Ha'avara* (Transfer) agreement, according to which German Jews emigrating to Palestine could transfer their assets to the *Ha'avara* organization. The money was used to purchase German goods needed in Palestine, while the migrants were given back part of their money after they arrived there.[4] Fourteen thousand Jewish families left Germany under this provision, which was the only way for them to retain some of their wealth. For most of them it was also the only path for legal emigration. As a result of the agreement, the market in Palestine actually saw an increased availability of German goods in the mid-1930s, leading to heated comments and accusations in the public sphere, which were reflected in the press. As with many other issues debated in Zionist politics of the time, here too the lines were drawn between the two major camps competing for leadership of the Zionist movement, the right-wing Revisionists and the socialist Labor movement. In the context of the German government's aggressive anti-Semitic policies and the calls for a boycott on the part of Jewish communities worldwide, it was easy to turn this issue into a political debate about blood money and cooperation with the devil. This debate, however, also had an impact on the immediate economic interests of many individuals and businesses. Boycotting German produce endangered the livelihood of many Jews who had immigrated from Germany and businesses that depended on German exports. More importantly, the Zionist leaders understood that the agreement was a vital source of material support for

2 Yfaat Weiss, The Transfer Agreement and the Boycott Movement: A Jewish Dilemma on the Eve of the Holocaust, in: Yad Vashem Studies 26 (1998), 30-37; The Anti-Nazi Boycott of 1933, available at American Jewish Historical Society, Internet Archive, ‹https://web.archive.org/web/20090116052255/http:/www.ajhs.org/publications/chapters/chapter.cfm?documentID=230› (last accessed May 3, 2020).

3 Ofer Aderet, Rage Replaced by an Embrace, in: *Haaretz*, June 26, 2015 (in Hebrew).

4 Weiss, Transfer Agreement, 129 f.

the growing *Yishuv*. Approximately 82 million marks worth of »Made in Germany« merchandise was transferred to Palestine in the years 1933-38 as part of the transfer agreement. Its contribution to the construction and success of the state-to-be was very significant. It also contributed to the sustained presence of German products in the economy of the *Yishuv*.[5]

The transfer agreement was severely criticized in light of what transpired thereafter during the war and the Holocaust. But these momentous events and their impact did not eventually keep German products out of the State of Israel. From the early postwar years, Jewish organizations, family members of Holocaust victims, as well as Israeli kibbutzim were engaged in negotiations and legal battles in occupied Germany in order to ensure that the mass robbery of Jewish property in Europe would not become a permanent reality simply because most of the previous owners had been murdered. German money and German products were therefore brought to the *Yishuv* even before the establishment of the state. Similar dynamics developed under very different conditions after 1948. Boycotts, controversies and much ambivalence persisted, and the term »Made in Germany« remained a constant uneasy presence.

In Israel of the 1950s and 1960s there was widespread public support for boycotting German products, including, for example, the operas and music of Richard Wagner. The call for boycotting German products in Israel was part of the process of constructing the memory of the Holocaust, but it was also associated with internal political conflicts. The boycott of products »Made in Germany« never became a formal policy in Israel and did not prevent the establishment of political, economic, scientific and cultural relations with the Federal Republic of Germany (FRG) after 1965. It belonged rather to the symbolic zone of the cultural and political life of the young state, expressing complexities of political self-definition. However, as a result of the *Wende* of 1990, the establishment of the European Union, German arms deals and weapon supply to Israel after the First Gulf War, the migration of Israelis to Berlin after 2000 and the »normalization« of the political affairs between the two countries, alongside the impact of global trade and the world economy, German products are no longer a controversial issue in Israel. A minor example: the German car industry,

5 Ibid., 151-160; Na'ama Riba, Tel Aviv Was Built with Raw Materials from Nazi Germany, in: Haaretz online, October 25, 2019, https://www.haaretz.com/israel-news/.premium-tel-aviv-s-white-city-was-built-with-raw-materials-from-nazi-germany-1.8019767; Dorothy Thompson, Refugees: Anarchy and Organization? (New York: Random House, 1938), 51-52; Jerusalem Boycott Committee on the Transfer, Hayarden April 4, 1935, 2 (in Hebrew); Conflicts at the Boycott Assembly in Tel Aviv, in: Haaretz October 21, 1934, 6 (in Hebrew).

such as Volkswagen, Daimler AG (Mercedes Benz), Opel and BMW, has had a considerable presence in the Israeli market since the 1950s. In one of its recent marketing campaigns in Israel, advertisements presenting Opel's cars as an example of »German quality« could be seen in major thoroughfares in Israeli cities. The resulting protest in some of the social media had no echo in the Israeli public sphere. There is historical irony in the fact that Opel Automobile GmbH had in fact been fully owned by the American company General Motors since 1931 and was sold to a French multinational car manufacturing group in 2017. »Made in Germany« is a term that has today become interwoven with global frameworks and international interactions. Moreover, some of the topics discussed below, from the invention of saccharin to nuclear power plants, demonstrate that German technology has long been connected to countries beyond its borders.

This volume seeks to explore the term »Made in Germany« and to discuss its implications in a variety of historical, social and cultural frameworks. The articles of this volume, some of which were first presented at an international workshop held at Tel Aviv University in June 2019, examine the role of technology in German history and culture from different perspectives. The *Jahrbuch* is divided into three main sections, presenting three major frames of discussion: the technological, the historical and the cultural. The articles in the first section explore the interactions between science, the education system and technology in Germany in comparison with other countries. The close connection between science and technology and a strong technical education system became a hallmark of German production from the second wave of the industrial revolution and also a common explanation for the success of Germany industry and economy. The stories told here, however, qualify some of the generalizations often made in this context.

In the second section, four historians analyse four different test cases, which offer starkly different views of the social, cultural and environmental impacts of technology in Germany since 1945. Two of the four focus on the history of the German Democratic Republic (GDR), one deals with West Germany and the fourth is mostly about the post-*Wende* Berlin republic. Technology itself is not the primary subject of any of them; they engage technology via its memorialization and consumption, through efforts to contain and control it or through the agency of its products and the manners in which they impact humans and their environments.

The third section of this volume offers a literary and philosophical perspective on the representation of German technology, mainly in the writings of German thinkers and authors of the modern period (1800–1950).

The articles deal with both utopian and dystopian visions, with anxieties and with a cultural critique of technology. The question of technology was understood as a historical and cultural one, associated with the question of humans and the future of humanity. Writing about technology in Germany (or about »German technology«) thus involved futuristic thinking, or at least attempts to write of and for the future. It involved ambiguous visions of enlightenment and progress, belonging (*Zusammengehörigkeit*) and detachment, and was linked with (often mythical) ideas about nature, origins and the meaning of the past.

Shaul Katzir, Sagi Schaefer, Galili Shahar

* * *

The English term »Made in Germany,« did not, of course, originate in Germany but in Britain. In the late nineteenth century, the world dominance of British industry came under threat due to competition from other developing economies, especially those of Germany and the United States. During the long economic depression of the late nineteenth century (1873–1896) many in Britain were alarmed by the growth of imports to their empire from foreign countries. Rejecting the reintroduction of protectionist tariffs or quotas (as Germany, for example, did in 1879), a British commission looked for other means for protecting their industry. Since foreign goods were regarded to be of lower quality, a mandatory mark of the origin of imported products would, the commission believed, make German and other foreign goods less attractive for the customer. The commission probably took its inspiration from the voluntary practice of marking manufacturing region to signify high quality. The best-known example in England was that of the Sheffield cutlery industry renowned for its hand-made products, which introduced the sign »Sheffield« or »Sheffield made« to protect itself from the competition of machine-made knives from other regions, not least from Germany. The 1887 »Merchandise Marks« act made labeling foreign origins mandatory for the British Empire. Within a few years, it led to similar international rules.[6]

Yet, as often, the results of the act were quite different from the intentions, especially regarding German goods. In the subsequent years, German products gained prestige for their quality for two main reasons: customers became aware that what they had earlier considered to be high-quality

6 Sidney Pollard, »Made in Germany«: Die Angst vor der deutschen Konkurrenz im spätviktorianischen England, in: *Technikgeschichte* 54 (1987): 183–195; Sigfrid von Weiher, 100 Jahre »Made in Germany«: Absicht und Auswirkung eines britischen Gesetzes, in: ibid., 175–182.

products of the domestic industry were actually manufactured in Germany. Second, in the same period, the German industry invested efforts in improving the quality of its products, which had previously been held in low esteem. That was not only a British view. For example, in 1876, Franz Reuleaux, an official German delegate to the Philadelphia world fair, criticized the products of his country as *billig und schlecht* (cheap and poor). Reuleaux was an engineering professor, who, as discussed in Wolfgang König's contribution to this volume, advocated mechanical engineering as an independent discipline. In his opinion, improved teaching and stronger technical disciplines would support the higher-quality industry that his country needed. His call evidently reached people in German industry who were willing to listen. By the end of the century the term »Made in Germany« had begun to mark quality rather than cheap products. German goods were still cheaper than British, but a British 1897 committee found that in many fields they were of better or equal quality in comparison to their domestically produced equivalents. E. E. Williams's 1896 best-selling *Made in Germany*, a collection of articles advocating protectionism, shows that the term had become a sign for alarm. Still, his alarm was due to its new presence (as the goods had previously been sold without the mark) and to the rise in German industrial production and exports, rather than to their quality. In any case, »Made in Germany« was no longer a term of contempt.[7]

At the beginning of the twentieth century, German industry was not an imitation of the more mature British industry but had acquired its own characteristics. While it had a strong heavy industry based on coal, which was still similar to the English one, it showed a particular strength in new industries like those related to chemical and electric technologies. In absolute numbers (disregarding its larger population), by 1913 German industry produced twice as much as the British in chemicals, electric appliances and non-ferric metals. Its major exports also included machine tools and optical instruments. Its strength in these industries was rooted in a diverse, large and strong technical education system, ranging from intermediate schools to different kinds of higher education institutions, including at the academic level the *Technische Hochschulen*, and in a tighter connection between science and industry than in places like England. The development of optical glass by Zeiss, which allowed it to surpass the older supremacy of French manufacturers, provides a clear example of successful

7 Pollard, »Made in Germany«; Weiher, 100 Jahre »Made in Germany«; Walter E. Minchinton, E. E. Williams: »Made in Germany« and after, in: *VSWG: Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte* 62 (1975), 229–242. J. H. Clapham, An Economic History of Modern Britain, Cambridge 1963, 3:37-40.

collaboration between science and industry. German chemical companies established the first industrial research laboratories in the late nineteenth century, followed later by American companies. The American imitation of the German system points to the international dimension of German practices. From the aftermath of World War I to recent times, the idea that scientific research could and should support economic growth has been internationally popular.[8] Yet, as discussed in the first section of this collection, German science, technical education and industry continued to bear some distinct characteristics and inner tensions.

Wolfgang König examines the role of scientific theory in German academic technical education by investigating the controversy over the place of mathematics in the curricula of mechanical engineering in the decades around 1900. Engineering professors like Franz Grashof, Reuleaux and Alois Riedler promoted the idea of engineering as an independent discipline, which they believed should be the proper basis for technical education. While they agreed that mathematics should be taught, they allocated it only a secondary place in relation to the traditional curricula. Their efforts were part of the struggle by engineers to make technology autonomous from the natural and exact sciences and endow it with the status of an independent science – *Technikwissenschaft*. They thereby strove to enhance its prestige, along with the meaning of *Technik* in German culture. Based in a strong independent technical system of higher education, they could proclaim more autonomy than their French colleagues (working under the dominance of mathematical sciences) and a stronger theoretical basis then their colleagues in the Anglo-Saxon world (which did not have the same tradition of technical colleges). The demand for the independent status of mechanical engineering was, therefore, a sign of the strength of German technical education and its theoretical character.

Désirée Schauz considers the relations between science and technology from the opposite perspective, that of science, and more specifically of science policy. She examines how the demand by industry and the state for knowledge that could be applied for technical purposes shaped, and actu-

8 Pollard, »Made in Germany«; Weiher, 100 Jahre »Made in Germany«; David Cahan, The Zeiss Werke and the Ultramicroscope: The Creation of a Scientific Instrument in Context, in: Jed Buchwald (ed.), Scientific Credibility and Technical Standards in 19th and Early 20th Century Germany and Britain, Dordrecht/London 1996, 67–117; Stuart M. Feffer, Microscopes to Munitions: Ernst Abbe, Carl Zeiss, and the Transformation of Technical Optics, 1850-1914, Berkeley, CA 1994; Stuart M. Feffer, Ernst Abbe, Carl Zeiss, and the Transformation of Microscopical Optics, in: Buchwald (ed.), Scientific Credibility, 23-66; Shaul Katzir, »In War or in Peace:« The Technological Promise of Science Following the First World War, in: *Centaurus* 59/3 (2017), 223–237.

ally generated, a German scientific policy in the aftermath of World War I. She identifies a shift in the German perception of the natural sciences in this period, from regarding them as an end in themselves – as a quest for knowledge, and as part of good education (*Bildung*) – to viewing them as a useful tool for technology. Although, as mentioned above, German scientists had already studied nature to help the process of technical development, Schauz claims that these earlier interactions did not lead to a significant change in national science policy, which occurred only after the war. This new perception of science resulted in the new, utilitarian way in which it was presented to the public and influenced the very practice of science, such as a turn to group work, as well as the allocation of resources to science in general and between different fields of study. She shows that some of the utilitarian characteristics of scientific research, which are often attributed to the post-World War II period and later, were already in place at the time of the Weimar republic.

There were two major reasons for this change in German science policy. The first, according to Schauz, was a sense of crisis regarding German science among both scientists and policymakers during the troubling postwar years. The second was the growth of international economic competition. Like the British politician who introduced the label »Made in Germany« forty years earlier, German science advocates saw international competition as an industrial and thus technical struggle. In the aftermath of World War I, and partly due to the war experience, science and scientific research were internationally regarded as crucial for the development of technology and the growth of national industry. For the Germans, like others, that meant that science should be more attuned to the needs of technology, especially in times when the nation could show its might only in the economic realm.

In their joint paper Simon P. Forster, Anthony S. Travis and Stefan Seeger take us from the discussions and practices of the teaching halls and science policy to the invention, development, production and technological transfer of a new product – saccharin (an artificial sweetener) and its production methods. Their story includes some of the salient characteristics of German technology of the late nineteenth century: a strong chemical industry and technology, close collaboration between science and industry and expertise based on its strong technical education system. These features allowed the invention and industrial production of saccharin, and, more generally, made German products a threat to British industry. Yet, saccharin was not exactly a »German-made« chemical. It was invented in the United States following a discovery in a German-style research laboratory; it was commercialized and went into large-scale production in Germany, from which it was exported, and then returned to industrial manufacture in the United States.

The convoluted story told by Forster et al. problematizes the concept of »made in Germany« (or any other country of origin). On the simple material and geographical level, saccharin was first »made in the USA« only thanks to the use of Swiss-made intermediates, produced also by German manufacturers but not by Americans. On a deeper level the story raises the question of what precisely was »made in Germany,« which parts of the American technology were German, and vice versa. What did Germany (and Switzerland, which had a similar kind of chemical industry) export to the United States in this case? The export included not only chemicals but also expert chemists (brought to enable the production in the United States) and German-style chemical research and technical utilization. The discovery and the invention based on it were made by scientists educated in Germany (Ramsen and Fahlberg) within the first German-style university in the United States (a model that has long since became an international standard). Its early industrial production in Germany (1887), where qualified chemists were available, also points to a sense in which it was part of German technology. In many respects, saccharin was therefore a German product, but in others it was not. The idea that a single country could claim to be the origin of a product or a technique was already problematic circa 1900. Our contemporary questions about the meaning and value of such a term in the globalized economy, in which different components and intermediates come from across the globe, are not so new. Already before World War I, science and technology were international endeavors. Notwithstanding, their particular national characteristics, materials, products, knowledge, experts and even methods and attitudes traveled across borders.

The story of saccharin shows Germany's high level of competency in technology, even if produced by German methods abroad, a scientific, technical expertise that supported new products, and a business-industrial environment that embraced it. Yet, it reveals also suspicion toward artificial products that characterizes other currents within German culture, pointing to its ambivalence toward technology. Backed by interests of the natural sugar industry and farmers, the suspicion toward synthetic products led to laws that drastically restricted the selling and production of saccharin in Germany. These pro-natural, anti-technical, anti-material sentiments are further discussed in the third section of this volume, while the second section focuses on other cases of embracing technology.

Shaul Katzir

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Technology is the most palpable medium through which we encounter change; it takes time until technological changes affect the social and physical worlds and further time for us to fully comprehend these effects. The current (spring-summer 2020) pandemic has brought about a worldwide adoption of video conferencing for a great variety of previously face-to-face human interactions, of which the most extensive in terms of numbers of users and social impact is teaching. We have only begun to raise questions and make assumptions about the broad long-term implications of distance learning, if it indeed becomes the dominant means of education. Among others, it is not yet clear what the consequences will be of, for example, the radical reduction of nonverbal communication in classes, the elimination of sites and spaces such as libraries, schoolyards, campuses, hallways and classrooms, or the sharp decline in the functions of classes and cohorts as communities, to name just a few.

The second section of this volume offers four very different frameworks for thinking about social, cultural and environmental worlds in interaction with technology, and the long-term impacts of these interactions, all four from the second half of the twentieth century but with tentacles reaching from as far back as the nineteenth century to our times.

Technology can, and often does, entail risk and evoke fear, especially in its early stages. The railway, for example, created anxiety regarding its safety and the potential death toll (which seems exaggerated from the perspective of the automobile society). Karin Zachmann writes about the mechanisms societies developed in order to contend with and regulate technology-created risks. The greater the perceived risks attached to a certain technology, the more urgent the challenge became for societies and organizations to devise systems to evaluate the risks and benefits of adopting it and establish procedures for regulating its usage. The advent of nuclear technology as a source of energy in the mid-1950s therefore posed a challenge of a greater order of magnitude than previous technologies for every state that chose to adopt it. By that time, the destructive power of nuclear weapons had been demonstrated and etched deep into the public psyche of Cold War populations around the world. Zachmann analyzes two related questions at the center of the debate regarding the risk nuclear energy entailed in the GDR. The first was how to establish and assess the necessary evidence required to evaluate risk; specifically, what the status of probability and statistics should be. The second question was more specific to the kind of relations with society that the GDR regime aspired to. It was difficult to reconcile probabilistic risk assessment calculation methods, developed within the Western capitalist economy and society, with the claim of a patriarchal state to offer full protection to its citizens. This approach was connected to pride in »Made in the GDR« and the liberating force of technology in its propaganda, which appeared also in the *Plattenbauten* discussed by Eli Rubin. Zachmann explores the discussions of these issues in professional and administrative circles and traces their developments over time.

The second and third articles in this section deal with the traces and legacies left behind by technology and the power and impact of these traces. Rubin examines the material objects produced in the particular circumstances of the GDR by means of innovative technologies for which these circumstances created the perfect conditions, such as massive buildings constructed of precast concrete, and mass-produced plastic objects of many kinds. In previous work, Rubin argued that innovative and massive usage of these technologies formed the basis of what for many East Germans actually became »real existing socialism,« a new world that replaced and erased the old. Based on a new-materialist analysis, Rubin here seeks to explain more closely the process whereby the erasure and the new reality came to be. As he explains, a growing awareness of the limitations of the humanist focus of the Enlightenment, blind to the agency of the material world during the Anthropocene, gives rise to new materialisms. These approaches seek to expose the actions of nonhuman components of the environment and their dialectical relations with human actions. He demonstrates that, once produced and used, *Plattenbau* buildings and plastic objects shaped the lives of millions of East Germans through creating new sensations; they acted on their consciousness and they still act, or interact, with residents, consumers, tourists and scholars today.

Rolf-Ulrich Kunze is also interested in the traces of technology that interact with human consciousness, but his approach is very different. His article analyses the memorialization of the steam locomotive, the traces that it left in the culture and public memory of West Germany. Steam engines are the technology most identified with the industrial revolution, and railway engines pulling trains behind them are its most recognized icons. The consistent forward movement of a heavy machine over uneven terrain, propelled by fire and smoke, has captured the imagination of generations and served as a prominent symbol of progress for almost a century. When the Deutsche Bundesbahn retired its last steam engines in 1977, an exhibition and a special issue of the *Eisenbahn Illustrierte* celebrated the history of the steam locomotive. Kunze examines both these acts of commemoration to discuss the role and the place of the memorialization of this technology in the cultural history of the FRG.

Milena Veenis's article, which closes this section of the volume, also deals with cultural memory, but focuses not on the memorialization of a heavy machine but on the production, imagery and consumption of a soft drink. Starting with ad campaigns for Club Cola, a Cola drink sold in unified Germany that was first produced in the GDR in the late 1950s, Veenis uses the history of Cola production and consumption in the GDR and the development of East Germans' attitudes toward Western consumption to take her analysis beyond the omnipresent label of »Ostalgie.« While the commercial film clips she analyzes clearly evoke the period of the GDR, the article shows that they engage a nuanced public discussion about East German agency and East German pasts. Veenis presents a narrative that connects GDR-period consumption with post-unification relations between East and West Germans. She uses the Club Cola commercials to analyze what is at stake in internal East German, as well as East-West German discussions about the past.

Sagi Schaefer

* * *

The idea of technology has, of course, a very long history and in ancient Greek culture it was associated not only with tools, skills and arts, but also with the methods and forms of truth (*Wahrheit*), with the uncovering of hidden essence. It is not by chance that one of its devices was performed on the stages of the Greek theater: the *Deus ex Machina* is perhaps one of the first »machines« in the ancient world of poetry and art, a crane that was used to bring a »solution« to human conflicts by divine force. Technology in the modern era was and still is understood as a major element of progress (*Fortschritt*) and civilization. In the German contexts, since 1750 technology has been part of cultural discourse and critique, signifying concepts of knowledge and science, ideas of labor, cultivation and progress, but also associated with alienation (*Entfremdung*), materiality and profane life. In German poetry, to recall Goethe and Hölderlin, the mechanical forms and monotonic rhythm, the cold, lifeless being of the machine, were depicted not as a promise, but rather as a danger to the future of humanity.[9] In the writings of German modernist authors, such as Ernst Toller's *Die Wandlung*, Georg Kaiser's *Gas* and Franz Kafka's »In der Strafkolonie,« in Expressionist art and films, in Dada's photomontages and in the prose and lyrics of the Neue Sachlichkeit, technology was a topos that represented the »Dialektic der Aufklärung.«[10] Technology, to follow this argument, was

9 See Hölderlin's poem »Hälfte des Lebens,« in: Sämtliche Gedichte, Frankfurt am Main 2005, 320.

10 Max Horkheimer/Theodor W. Adorno, Dialektik der Aufklärung: Philosophische Fragmente [1944], Frankfurt am Main 1997.

an instrument of rational understanding of being that turned into a method of government, self-discipline and punishment. The critique of technology, represented in its (neo-)Marxist form by Walter Benjamin, Theodor Adorno and Max Horkheimer, or in its phenomenological, and subsequently radical conservative form by Martin Heidegger, was also associated with the German term *Kultur*, interpreted as an »original« German cultural concept that stood in contrast to the so-called French and Anglo-Saxon idea of *Zivilization*.[11] Philosophy, poetry and art were understood in this conceptual framework as forms of humanistic progress that opposed the constitutional, commercial, scientific-technical forms of Western civilization.[12] This does not mean that these dichotomies and false images of cultures should be accepted, but rather that their impact on the European cultural and political sphere around 1900 should be acknowledged.

The third section of this volume attests to the complexity of the idea of technology in Germany by considering three major manifestations of technology in the worlds of the Enlightenment and Modernism. The first article by Oliver Lubrich presents the functions of technical instruments and devices, especially measuring tools, in the enterprises of the German thinker, scientist and traveler Alexander von Humboldt. Technology, Lubrich argues, was a source of measurement in Humboldt's projects – a way of understanding the quantitative structure the universe – but one that was implicated in colonial frameworks and in comparative contexts of cultures. In Humboldt's enterprises, technical instruments were also symbols of scientific knowledge, a means of representing the idea of research, the observation of nature, measurements and findings. Humboldt's devices and his technical visions and plans (*Entwürfe*) were also objects (*Gegenstände*) for artistic and literary representation, inspiring thinkers, writers and painters. In that sense Humboldt's visions and practices of technology were not only an expression of the progressive concept of enlightenment, on both the theoretical and the practical level, but also a source of creative thinking on the nature and measures of the world.

The second essay in this section, by Dorit Müller, discusses Alfred Döblin's dystopic novel *Berge Meere und Giganten* (1924), which depicts a futuristic techno-political vision of a gigantic war between humans and nature. Döblin's novel, which was based not only on creative, imaginary and fearful visions but also on encyclopedic knowledge of both technical and scientific disciplines, such as chemistry, geology and engineering, tells

11 Martin Heidegger, Die Frage nach der Technik, in: Die Technik und die Kehre, Stuttgart 2002, 5-36.

12 Norbert Elias, Über den Prozeß der Zivilisation: Soziogentische und psychogenetische Untersuchungen [1936], Frankfurt am Main 1997, 1:89-130.

the story of a global enterprise seeking to transform matter and the forms of human life. The novel is, however, not only a literary document of the modernist technological visions of the 1920s or an example of the science-fiction genre of its age. It should be understood as a critical statement regarding the civilizational project as a whole – the human dominance over nature and its destructive consequences. It should also be seen, Müller argues, as an early attempt to discuss the Anthropocene – the present epoch in which the human civilizational project is changing the very matter of being, re-creating and destroying natural forms of life. In this context Döblin's novel contributes to the current debate on climate change, offering his readers both a literary reference and a historical perspective.

The third contribution to this section, by Rony Klein, deals with Heidegger's philosophical critique of technology, associated with his mythopoetical concept of origin (*Ursprung*) and his attempt to reclaim the meaning of *Techne*. Klein argues that Heidegger viewed technology not merely as a form of practical knowledge and implication, but rather as a metaphysical plan. From Plato to Nietzsche, technology has been the core vision of the Western Weltanschauung. According to Heidegger, the entire history of philosophy is imprinted by this metaphysical plan of knowledge, in which technology played a constructive role: inquiry, usage, instrumental thinking, objectification (*Verdinglichung*) and framing (*Ge-stell*) are technological values inflecting the history of thought. Against this major tendency in Western civilization, Heidegger offered a Step-Back (*Schritt zurück*) into the hidden realm of thinking, embodied by the Greek tragic thinkers and poets, who were translated into German in the poetical work of Friedrich Hölderlin. Hölderlin introduced to the German people the idea of an origin and a vision of an authentic German being. In the 1930s and 1940s Heidegger's engagement with the question of technology and the poetic idea of Being (*Sein*) was associated with his troubled affinities with the Third Reich, signifying a dark chapter in the history of German thought.

The term »Made in Germany,« alongside its historical, sociocultural, scientific and economic implications, is therefore deeply imbued with philosophical ambiguities. Technology refers not only to tools, skills, devices, machines, methods and frames of production, but also to a form of knowledge, a way of understanding and engaging the world.

Galili Shahar

Technologie

Wolfgang König

Der Streit um die Mathematik an den Technischen Hochschulen um die Jahrhundertwende

Einleitung

Besonders im 19., aber auch noch im 20. Jahrhundert pflegten die Technikwissenschaften und die Mathematik ein spannungsreiches Verhältnis. Die Technikwissenschaftler waren zwar der Auffassung, dass die Mathematik in der Ingenieurausbildung und in der technischen Forschung unabdingbar sei. Umstritten war aber, auf welchem Niveau sie gelehrt werden, welchen Raum sie einnehmen sollte und wie sie zu vermitteln sei. Die Differenzen in diesen Fragen resultierten in erster Linie aus den Technikwissenschaften selbst. Als junge Wissenschaftsgruppe war sie noch auf der Suche nach ihrem Selbstverständnis. Eine Abhandlung über das Verhältnis der technischen Fächer zur Mathematik muss deswegen nicht zuletzt die Veränderungen in den Technikwissenschaften selbst in den Blick nehmen. Letztlich entwickelten die deutschsprachigen Technikwissenschaften ein spezifisches Profil, das bis heute besteht und das sie von jenen in Frankreich oder in den angloamerikanischen Ländern unterscheidet.

Die Unterschiede zwischen den deutschsprachigen und den englischsprachigen bzw. französischen Technikwissenschaften lassen sich bislang nur in sehr allgemeiner Weise erfassen. Vergleichende empirische Arbeiten existieren nicht. Es scheint, als hätte die Mathematik in den amerikanischen und französischen Technikwissenschaften einen höheren Stellenwert als in den deutschsprachigen Ländern gehabt und sei auch weniger infrage gestellt worden. In Großbritannien dürften dagegen ähnliche Diskussionen wie in Deutschland geführt worden sein.

Ich widme mich in meinem Beitrag in erster Linie dem deutschen Maschinenbau, denn der Maschinenbau bildete im behandelten Zeitraum quantitativ und qualitativ den Kern der Technikwissenschaften. Die Bautechnik wiederum war stark durch den Maschinenbau geprägt. Selbiges gilt auch für die noch junge Disziplin der Elektrotechnik, die sich nach 1880 aus der Physik und dem Maschinenbau herausbildete.[1] Erst im

1 Vgl. König, Technikwissenschaften.

20. Jahrhundert entwickelte die Elektrotechnik eine eigene Methodologie, die jedoch wesentlich durch die Physik beeinflusst war.

Der Beitrag beginnt mit einem Überblick, der die Jahrzehnte zwischen 1870 und 1900 als den entscheidenden Zeitraum für die Entwicklung der Technikwissenschaften von einer angewandten Naturwissenschaft zu einer eigenständigen Wissenschaft identifiziert. Es folgt eine Betrachtung der an den Technischen Hochschulen gelehrten Mathematik bis zur Jahrhundertwende. Drei bedeutende Technikwissenschaftler werden daraufhin untersucht, welchen Stellenwert die Mathematik in ihrem Werk einnahm. Dabei fällt der Höhepunkt des Wirkens von Franz Grashof in die Zeit bis 1890, bei Franz Reuleaux liegt er bis etwa 1900 und bei Alois Riedler in die Jahre zwischen 1890 und 1920.

Der Name Alois Riedler ist zudem verbunden mit der Entstehung der modernen Technikwissenschaften als experimentelle Erfahrungswissenschaften. Der Charakter der modernen Technikwissenschaften wird am Problem der Modellbildung erläutert. Die Differenzen zwischen Mathematikern und Ingenieurprofessoren fanden in markanter Weise im Mathematikerstreit im Jahr 1897 einen Ausdruck, wobei diese Reformdiskussion für die Dauer des Kaiserreichs zu keinem allgemein akzeptierten Ergebnis kam. Sie fand eine Fortsetzung in der Weimarer Republik und wurde in eine Reihe von Kompromissen überführt.

Das Selbstverständnis der Technikwissenschaften

Hinsichtlich des Selbstverständnisses der Technikwissenschaften lassen sich cum grano salis zwei Phasen unterscheiden.[2] In der ersten Phase bis etwa 1870 verstanden sich die Technikwissenschaften als mathematisch darzustellende angewandte Naturwissenschaften. Sie strebten danach, sich zu exakten Wissenschaften zu entwickeln, und orientierten sich weitgehend an den naturwissenschaftlichen und mathematischen Universitätsdisziplinen. Mit dieser Strategie werteten sie sich zweifellos akademisch auf. Äußere Zeichen dieses Erfolgs waren etwa die Umbenennung der Gewerbe- und Polytechnischen Schulen in Technische Hochschulen seit den 1860er Jahren und das um die Jahrhundertwende verliehene Promotionsrecht.

Die Erfolge waren allerdings mit Kosten verbunden. Aufgrund ihres hohen Abstraktionsgrads entfernten sich die Technikwissenschaften zunehmend von der technischen Praxis, und damit verbunden kamen Zweifel auf

2 Eine Überblicksdarstellung zur Geschichte der Technikwissenschaften liegt bislang nicht vor. Monographien zur Geschichte der Technikwissenschaften behandeln einzelne Disziplinen, Akteure oder Institutionen.

an der praktischen Eignung der Ingenieurabsolventen. Kritik an dieser Entwicklung übten zunächst vor allem Industrielle und Manager.

In der zweiten Phase, nach 1870, entwickelte sich an den Technischen Hochschulen selbst eine Bewegung gegen die fortschreitende Theoretisierung. Die Technikwissenschaften strebten danach, einen Beitrag zur technischen Praxis zu leisten, und Praxisbezug wurde als Stärke und Ausweis ihrer spezifischen Wissenschaftlichkeit herausgestellt. In den Technikwissenschaften entstand in der Folge ein neues Selbstverständnis, das in den Grundzügen auch heute noch gilt: Sie wurden zu experimentellen Erfahrungswissenschaften. Und sie beriefen zunehmend Professoren, die praktische Erfahrung aus der Industrie mitbrachten. Zahlreiche dieser Professoren unterhielten private Ingenieurbüros, die gewissermaßen eine Brücke zwischen Hochschule und Industrie bildeten.[3] Die Technikwissenschaften rezipierten weiterhin Ergebnisse aus den Naturwissenschaften und verwandten mathematische Methoden. Aber sie setzten diese selektiv ein und formten sie problembezogen um.

Die sich herausbildende spezifische technikwissenschaftliche Methode beruhte auf vier Säulen:[4]

- *erstens* auf der Rezeption naturwissenschaftlicher Erkenntnisse und deren Umsetzung in technische Regeln,
- *zweitens* auf der Entwicklung von den technischen Problemen angemessenen Berechnungsverfahren,
- *drittens* auf dem systematischen Experimentieren unter praxisnahen Bedingungen und
- *viertens* auf dem Sammeln und Sichten von Erfahrungen aus der industriellen Praxis und deren Umsetzung in technische Regeln. Mithilfe dieser Methoden schufen die Technikwissenschaften Modelle, welche die technischen Probleme adäquat abbildeten.

Wissenschaftliche Disziplinen lassen sich in Bezug auf ihren Gegenstand, ihre Methoden und Ziele sowie ihre Institutionalisierungsformen vergleichend betrachten. Besonders unterschieden sich die Technikwissenschaften von anderen Wissenschaften durch ihre Ziele. Ihnen ging und geht es nicht allein um Welterkenntnis, sondern auch um Weltgestaltung. Sie suchen nach gegenständlichen Mitteln, um gesellschaftliche Ziele umzusetzen. Sie arbeiten technische Potenziale aus und empfehlen deren Überführung in technisch-gesellschaftliche Praxis.

3 Vgl. hierzu König, Engineering Professors.

4 Vgl. zur Theorie und Methode der Technikwissenschaften: Müller, Arbeitsmethoden; König, Technikwissenschaften, 324 ff.; Banse, Erkennen.

Zur Charakterisierung dieser Ziel-, Zweck-, Zukunfts- und Handlungsorientierung der Technikwissenschaften sind eine ganze Reihe von Begriffen vorgeschlagen worden. Da ist die Rede von finalen, intentionalen, teleologischen, strategischen, präskriptiven, praxisorientierten Wissenschaften, von Möglichkeits-, Gestaltungs- und Handlungswissenschaften. Ich präferiere im Folgenden den Begriff der Handlungswissenschaften – in Abgrenzung von den Erkenntniswissenschaften wie der Physik oder den Geisteswissenschaften.

Programmatisch waren die angeführten Zielsetzungen bereits bei der Institutionalisierung der Technikwissenschaften in der Frühindustrialisierung angelegt. Die Regierungen versprachen sich von den Gewerbe- und Polytechnischen Schulen, dass diese die Industrialisierung in Deutschland vorantreiben und damit dem englischen Vorbild näherkommen würden. Allerdings waren die technischen Unterrichtsanstalten – nicht zuletzt aufgrund ihrer theoretischen Ausrichtung – hierzu lange Zeit nicht in der Lage.[5]

Die Mathematik an den Technischen Hochschulen im 19. Jahrhundert

Bis etwa 1870 wurden die mathematischen Inhalte an den technischen Schulen häufig von Technikern unterrichtet.[6] Dies war weniger eine programmatische Entscheidung als aus der Not geboren. Die Zahl der Lehrkräfte war insgesamt so gering, dass man sich keine spezialisierten Mathematiker leisten konnte, und so war das Niveau des mathematischen Unterrichts relativ niedrig.[7] Dabei muss man allerdings bedenken, dass die Schüler sehr jung waren und über eine begrenzte Vorbildung verfügten.

Dies änderte sich seit etwa 1870.[8] Die Technischen Hochschulen expandierten, und mit wachsenden finanziellen Ressourcen beriefen sie jetzt auch zunehmend qualifizierte, teilweise hervorragende Mathematiker. Diese hatten ihre Ausbildung an den Universitäten erfahren, an denen die »reine«, d. h. theoretische Mathematik dominierte, angewandte Mathematik war kaum vertreten. Technikwissenschaftliche Fragestellungen lagen diesen Mathematikern eher fern, und so waren sie schlecht aufgestellt, um den Ingenieurstudenten das mathematische Rüstzeug für ihren Beruf mitzugeben. Stattdessen beriefen sie sich häufig darauf, dass eine hochwertige Mathematik das logische Denken schule. Viele Mathematiker betrachte-

5 Vgl. König, Zwischen Verwaltungsstaat.
6 Vgl. zur Geschichte der Mathematik an den Technischen Hochschulen: Hensel u. a., Mathematik. Die Darstellende Geometrie untersucht Benstein, Zwischen Zeichenkunst.
7 Vgl. Hensel, Auseinandersetzungen, 12 f.
8 Vgl. ebd., 16 ff.

ten die Technische Hochschule als ungeliebte Zwischenstation und sehnten den Ruf an eine Universität herbei. Die Technikwissenschaften waren nicht in der Lage, an dieser misslichen Situation etwas zu ändern. Die Berufungsverfahren waren eine Angelegenheit der Allgemeinen Abteilung, in welcher die Technikwissenschaften weder Sitz noch Stimme besaßen.

Der Anteil der Mathematik in den Studienplänen des Maschinenbaus betrug Ende des 19. Jahrhunderts knapp 15 Prozent.[9] In den ersten beiden Studienjahren lag er jedoch weit höher, im ersten Studienjahr bei etwa 55 Prozent, im zweiten bei etwa 40 Prozent. Über den Umfang der Mathematik in den Curricula tobten in den Jahrzehnten um die Jahrhundertwende heftige Auseinandersetzungen. Dessen ungeachtet blieb er im gesamten Zeitraum zwischen 1860 und 1930 im Großen und Ganzen auf einem ähnlich hohen Niveau.

Die ungleiche Verteilung der mathematischen Studieninhalte hing damit zusammen, dass die propädeutischen Fächer vor allem in der ersten Studienhälfte gehört wurden, die technischen Fächer in der zweiten. Man betrachtete dies als eine logische und sinnvolle Gliederung des Studiums in zwei Teile. Darüber hinaus erkennt man hier den Einfluss des französischen Systems, denn dort studierten die angehenden Ingenieure zunächst an der École Polytechnique mit Schwerpunkten auf der Mathematik und den Naturwissenschaften. Anschließend wechselte man an die verschiedenen Écoles d'application, wo der Schwerpunkt auf den technischen Fächern lag.

Technikwissenschaftler und Mathematik: Drei bespielhafte Vertreter

Im Folgenden werde ich drei bekannte Technikwissenschaftler und ihre Haltung zur Mathematik vorstellen. Dabei lassen sich Franz Grashof und Franz Reuleaux der theoretischen Ausrichtung in den Technikwissenschaften zurechnen, wenn ihre Vorstellungen auch ganz unterschiedlich waren. Alois Riedler war über einige Jahre der Wortführer der praktischen Richtung.

Franz Grashof (1826-1893)[10] publizierte seine Arbeitsergebnisse in dem dreibändigen Werk »Theoretische Maschinenlehre« (1875-90). Darin bemühte er sich, Maschinenkonstruktionen durch ein System von mathematisch formulierten mechanischen und physikalischen Regeln und Gesetzen zu erfassen. Grashofs Werkzeug war die analytische Rechnung. Er benutzte eine anspruchsvolle Mathematik mit Infinitesimal- und Differentialgleichungen höherer Ordnung. Dies war allerdings nur möglich, weil er starke kontrafaktische Annahmen machte. Er räumte selbst ein, dass

9 Vgl. ebd., 25.
10 Vgl. König, Künstler, 28-32.

sich aus seinen theoretischen Arbeiten kaum praktische Konstruktionen ableiten ließen. Selbst der Mathematiker Felix Klein warf Grashof eine »Vernachlässigung der technischen Wirklichkeit« vor.[11] »Die mathematische Betrachtung setzt aufgrund physikalisch scheinender Annahmen ein, ohne daß die wirklichen Verhältnisse durch Experimente hinreichend geklärt sind.« Grashofs Vorgehen lässt sich so charakterisieren, dass er an einer virtuellen Technikwelt demonstrierte, wie weit man mit der Mathematik kam.

Franz Reuleaux (1829-1905)[12] war bestrebt, den Maschinenbau zu einer eigenständigen Gesetzeswissenschaft zu entwickeln. Einen zentralen Stellenwert nahm dabei die Arbeit an Begriffen in Form von Benennungen, Definitionen und Klassifikationen ein.[13] Mit seiner konkreten technikwissenschaftlichen Utopie setzte sich Reuleaux von drei zeitgenössischen Alternativen ab: *erstens* von der Interpretation der Technik als angewandter Naturwissenschaft, *zweitens* von der Auffassung, das Wissenschaftliche der modernen Technik liege in der zugrundeliegenden Mathematik, und *drittens* von einer Praxeologie, die sich auf inkohärente Ad-hoc-Aussagen beschränkte.

In seinem Werk »Constructeur« distanzierte sich Reuleaux explizit von der Auffassung, Technik sei angewandte Mathematik:[14] »Viele sind nämlich der Ansicht, es übe der Maschinenconstructeur der Schule eine auf rein mathematischen Grundsätzen beruhende Thätigkeit aus, deren Ergebnisse sich durch Rechnen, durch mathematische Operationen ermitteln liessen; […] sie halten […] die ›Maschinenbaukunde‹ für ›angewandte Mechanik‹.« An anderen Stellen wandte er sich gegen das »ins Masslose anwachsende Ziffern- und Formelwesen«, bezeichnete aber gleichwohl die Mathematik als »unentbehrlich«.[15]

Man interpretiert diese Äußerungen wohl richtig, wenn man schlussfolgert, dass Reuleaux – ähnlich wie die Praktiker – die Mathematik als notwendig für die Technikwissenschaften betrachtete, wenn diese in ihr auch nicht aufgingen und nicht aufgehen konnten. Darüber hinaus stellte die Mathematik mit ihrer logischen Struktur und ihrer Axiomatik – mehr noch als die Naturwissenschaften – ein Methodenideal dar, dem Reuleaux in seiner Kinematik nacheiferte.[16]

11 Manegold, Universität, 130 (hier das Zitat).
12 Vgl. König, Gelehrte.
13 Vgl. z.B. Reuleaux, Theoretische Kinematik, 596.
14 Reuleaux, Constructeur, 2. Aufl., VIII.
15 Reuleaux, Theoretische Kinematik, IXf.; vgl. auch Reuleaux, Wie beschreibt, 126 f.
16 Vgl. Ihmig, Verhältnis, 27 ff.

Wie Reuleaux insistierte auch Alois Riedler (1850-1936)[17], die Technik sei keine angewandte Naturwissenschaft. Den entscheidenden Unterschied machte er an den andersgearteten Zielsetzungen fest. In den Technikwissenschaften gehe es um »Gestaltung«, also um ein praktisches Ziel. Riedler wies auf die Komplexität der Technik hin, auf ihre Singularität und Historizität, auf Probleme und Grenzen der Erkenntnis. Gesetzesaussagen könne es deshalb in der Technik nicht geben, höchstens Regeln mit einem eingeschränkten Erkenntnisbereich. Er markierte Unterschiede zwischen dem auf Reduktion angelegten naturwissenschaftlichen Experiment und dem technikwissenschaftlichen, welches ein hinreichendes Maß an Komplexität bewahren müsse. Er machte darauf aufmerksam, dass das entscheidende Problem in den Technikwissenschaften in der Modellbildung liege und hierfür die Mathematik und die Naturwissenschaften wenig Hilfe leisten könnten. Diese und andere theoretische Aussagen finden sich verstreut in Riedlers Werken. An keiner Stelle arbeitete er sie systematisch aus. Tatsächlich wurden sie in der ohnehin spärlichen Forschungsliteratur auch weitgehend übersehen.

In seinen zahlreichen programmatischen Beiträgen zur Ingenieurausbildung und den Technikwissenschaften betonte Riedler durchwegs den Vorrang konstruktiv orientierter Lernziele, wie der Entwicklung des Beobachtungs- und Anschauungsvermögens, gegenüber stärker theoretisch orientierten, wie dem logischen Schließen, der Beweisführung und der Begriffsbildung. Riedlers Schüler Otto Kammerer verstand unter anschaulichem Denken die »Fähigkeit, räumliche Vorstellungen zu wiederholen und neu zu bilden«.[18] Dies sei im Feld der Technik wichtiger als die Fähigkeit, komplexe Zusammenhänge in Begriffe zu fassen. In der Mathematik gebe es mit Analysis und Algebra stärker dem begrifflichen Denken verbundene Bereiche, während die Darstellende Geometrie und bestimmte grafische Darstellungsmethoden stärker mit dem anschaulichen Denken verbunden seien.

Riedler sprach der Mathematik durchaus eine hohe Bedeutung zu:[19] »Die *Mathematik* als wichtigstes Hilfsmittel eigenartiger strenger Geistesschulung ist die Grundwissenschaft für alles Erfassen der Dinge nach Maß und Zahl«. In den Technikwissenschaften komme sie als Hilfsmittel zur Anwendung:[20] »Die Rechnung ist das wirksamste *Hilfsmittel*, weil sie eine genügend vollständig gewonnene Erkenntnis in *allgemeinster* Form ausdrücken kann, die zugleich die entwicklungsfähigste ist und immer die

17 Vgl. König, Gelehrte.
18 König, Künstler, 58-62.
19 Riedler, Ziele, 305.
20 Riedler, Wirklichkeitsblinde, 12.